JAN 17 1912
PUBLIC LIBRARY
OF THE
CITY OF DETROIT

POWER

Volume No. 35, No. 3.
Issued Every Tuesday.
Hill Publishing Company.

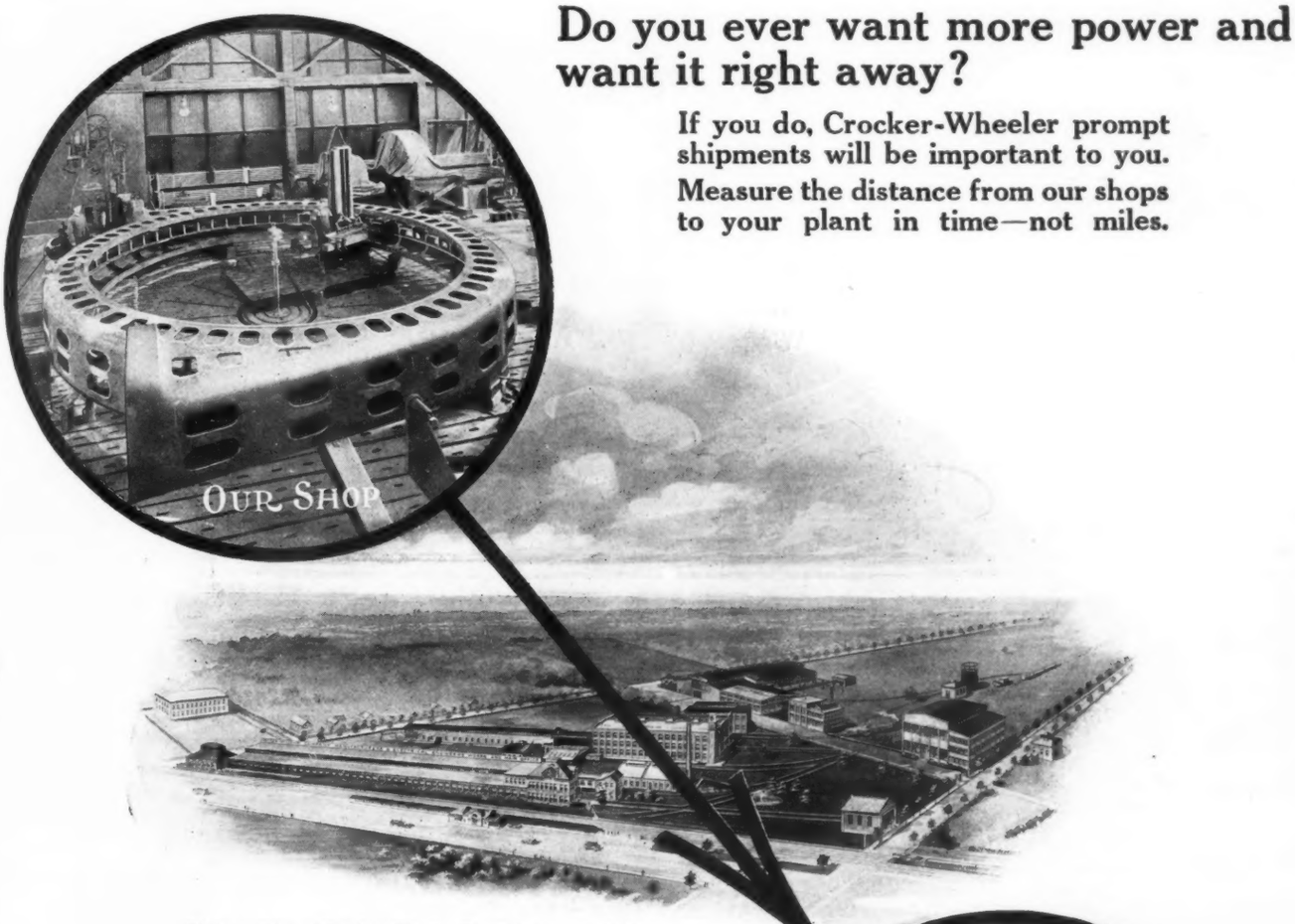
NEW YORK, JANUARY 16, 1912.

Price, 5 cents.
Outline of Topics, 50.
Index to Advertisers, 39.

Do you ever want more power and want it right away?

If you do, Crocker-Wheeler prompt shipments will be important to you.

Measure the distance from our shops to your plant in time—not miles.



Birdseye View of Crocker-Wheeler Plant at Ampere, N. J.

The following are some characteristic Crocker-Wheeler shipments:

One 400 K.W. 100 RPM., 250-V. generator shipped in FOUR WEEKS from receipt of order to Swift & Co., Chicago.

One 1200 K.W., 11000/600 V synchronous motor generator set shipped in 6 WEEKS to British Columbia Ry. Co., Vancouver, B. C.

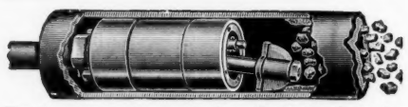
Compare these with the ones you are accustomed to.

Write our nearest office for full particulars regarding *your* proposition.

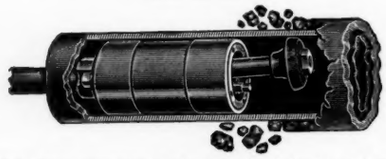
Crocker-Wheeler Co.

Ampere, N. J. Birmingham Boston Chicago Cleveland
Denver Detroit Newark New Haven
New York Philadelphia Pittsburg San Francisco Syracuse

An Awakening



The Dean removing scale from the tube of a water tube boiler.



The Dean removing scale from the tube of a return tubular boiler.

Free Trial Offer

We'll loan you a DEAN for free trial in one boiler. We won't hurry you with the test, force the cleaner on you, nor get sore if we don't effect a sale. We simply want you to see what a money-saving proposition we have. Then it's up to you to decide what to do with it.

Ten years ago the DEAN BOILER TUBE CLEANER started a revolution in boiler cleaning.

Up to that time there was no way of cleaning a fire tube boiler and for cleaning water tube boilers there was only the slow tedious boring methods which removed only the soft layers of scale and left a hard flint-like layer right next to the metal.

And almost everybody used compounds.

A trial of the

Dean Boiler Tube Cleaner

was all that was necessary to convince the engineer that the DEAN did more thorough work, in less time, at smaller cost than any other means.

Lots of engineers were afraid of the *vibration method* of tube cleaning at first but those who were the biggest doubters are our best friends today.

They have awakened to the fact that there is just *one way* to get off the scale clear down to the metal of the tube, and do it quickly—the DEAN.

Why not try the DEAN yourself?

The Wm. B. Pierce Company

Jewett Building - - Buffalo, New York

Chicago Office: 801 Steinway Bldg.

The CO_2 Engineer

The *coming* engineer—the man who will command the highest wages and be in greatest demand—MUST be a CO_2 engineer.

He must know how to make use of *flue gas analysis* as an aid in building up furnace efficiency.

The CO_2 engineer *knows* when the method of firing is wrong, when the draft is not properly regulated, when surplus air is entering the furnace.

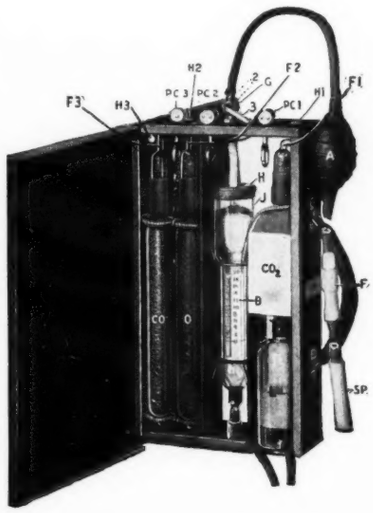
That *means* that he can correct the faults—and save *avoidable* loss due to these conditions.

Our FLUE GAS ANALYSIS INSTRUMENT makes this flue gas analysis business *extremely simple* and *inexpensive.*

There's nothing intricate about the apparatus—a fireman can operate it. It is sold at a price within the reach of any man's pocketbook.

The instrument will give the engineer a coal-saving ability that influences advancement in position and salary.

Every ambitious engineer ought to own one and by our easy payment plan he can own one without noticing the cost. *Write for circular.*



The Wm. B. Pierce Company

Jewett Building - - Buffalo, New York

KEYSTONE GREASE

KEYSTONE TRADE MARK REGISTERED U.S. PAT. OFF.

With Keystone Users Everywhere

A Visit To Brother Postlethwaite In Arizona

BROTHER POSTLETHWAITE is a jovial engineer of English descent, who has been operating a Power Plant out in a small town in Arizona for over 25 years—and using Keystone Grease since the first day he went on the job. He's in a position to speak with authority on Keystone Grease

"Blow me if this isn't cocky Keystone Grease come in to have a chat and a pipe with me," says he when our Salesman calls.

"Glad to see you, old boy, and proud to tell you that the grease is as fine as ever, still giving the best results. Dem' me if you'll find an empty cup or a hot box in the plant."

And those are the conclusions to which the continued use of Keystone Grease *always* leads.

Don't Forget Our Free Offer

Our offer to send you—absolutely without charge—a Can of Keystone Grease, a Grease Cup and an Engineer's Cap. We want you to try Keystone Grease. For an actual trial of "Keystone" is the best proof for you as well as for us. The coupon brings Grease, Cap and Cup—fill it out and return—today.

KEYSTONE LUBRICATING CO.

Executive Offices and Works

21st, Clearfield and Lippincott Streets Philadelphia, Pa.

Branch offices and warehouses in the principal cities of the United States.
Agencies in the principal countries throughout the world.

No Connection With The Oil Trust

A SAMPLE FREE

KEYSTONE LUBRICATING COMPANY, Phila.

Please send us a large size sample of Keystone Grease, sufficient for testing purposes, and one Brass Grease Cup and Free Engineer's Cap. It is thoroughly understood that no charges whatsoever will be made for sample, cup or cap, and all express charges will be paid by you.

Name of bearing where sample will be tested.....
Its width..... Combined horsepower of engines.....
Tap size of cup.....
FIRM.....
Per .....
City ..... State.....
Size cap required.....**CUT OUT THIS COUPON AND MAIL IT TO-DAY** Dept. B—1-16-12

Fig. 433
Brass, Top Outlet
Encased Spring

THE OBJECT

of a safety valve is to Relieve an Excess of Pressure, But No More, and one that does relieve more is wasteful and expensive.

Neither is a valve with excessive lift needed, nor is it desirable, because it is not durable, as it causes a tremendous wear on the seating surface

Fig. 630
Iron
Encased Spring

Lunkenheimer Pop Safety Valves

will Promptly Relieve the Overpressure Only, and nothing more. They can be regulated to reduce the pressure only one pound, if such close regulation is desired; will not chatter or hammer themselves to pieces; will not stick, and adjustment of the pop and pressure can be made from the outside of the valve.

All parts subjected to wear are renewable, making the valves practically indestructible.

The very best material procurable is used,—the high grade bronze composition containing a large percentage of copper and tin, while the iron is very hard and of close grain.

They can be had with either brass or iron bodies, made in all standard sizes.

Specify and insist upon securing genuine Lunkenheimer make. Do not accept substitutes,—they are never as good as the genuine.

"MOST supply houses sell them—yours CAN—if they Dont or Wont—tell US."

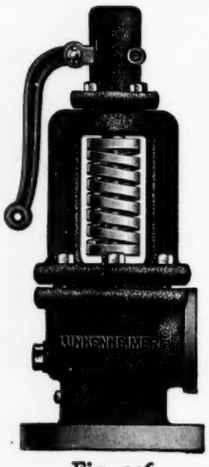


Fig. 146
Iron
Outside Spring

The Lunkenheimer Company

Largest Manufacturers of High Grade Engineering Specialties in the World

General Offices and Works: CINCINNATI, OHIO, U. S. A.

New York
64-68 Fulton St.

London, S. E.
35 Great Dover St.

Boston
138 High St.

Chicago
186 N. Dearborn St.

Fig. 44
Brass
Outside Spring

"How"
No. 5

How To Get Full Value From Coal

¶ There are any number of different ways in which you can waste coal—

¶ Every engineer knows them—

¶ But it is a fact that *one* of the biggest coal wasters—*is scale.*

¶ Scale chokes up the boiler tubes—it encrusts the tubes and plates—

¶ So that in order to get any heat through the tubes, you've got to keep on adding more and more coal.

¶ It only takes about 1/16 of an inch of scale to make 12.6% more coal necessary.

¶ And then think of how much less steam you get—even with the extra coal—to say nothing of the increased labor and expense.

¶ By using Dearborn Treatment, prescribed especially to suit the particular conditions of your plant—

¶ You will prevent the formation of scale.

¶ And in this way prevent a big waste of coal—at the same time getting full value out of the coal you burn.

¶ Send us a gallon of your feed water—this will be analyzed in our well equipped laboratory—

¶ Which analyzes over 8000 samples of feed water annually.

¶ And then we'll let you know exactly how much Dearborn Treatment that will put an end to *your* scale worries will cost. Suppose you send the gallon today.

Dearborn Drug & Chemical Works

Robert F. Carr, Pres.

General Offices, Laboratory and Works, Chicago
General Eastern Offices, 299 Broadway, New York

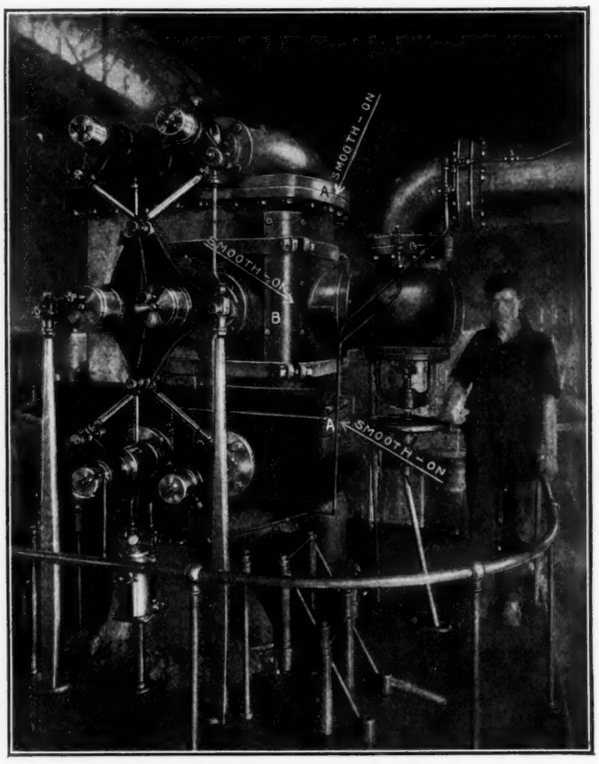
Branch Offices in Principal Cities

"How"
No. 6
Next Week

Steam Cylinder Repaired

When a man writes a letter like the following you must admit there must be some pretty strong features about the material he refers to:

READ EXPLOITS OF SMOOTH-ON CEMENTS *AND* SMOOTH-ON CORRUGATED GASKETS



VAN HOUTEN AND PROSPECT STREETS,
PATERSON, N. J.

PATERSON, N. J., March 8, 1909.

SMOOTH-ON MFG. CO.,
Jersey City, N. J.

Gentlemen:—

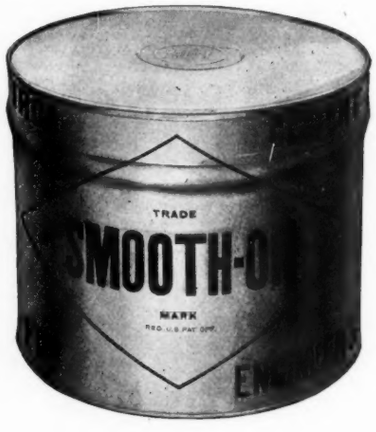
In regard to our experience with your Smooth-On Corrugated Gaskets, beg to say that we had a particularly hard cylinder head joint to hold and after trying a number of different packings for this joint, among which was corrugated copper, all of which failed to hold for any great length of time, we decided to try one of your corrugated Smooth-On Gaskets on this joint, which we did, and it has now been in use about one year carrying 160 lbs. pressure and has given us no further trouble. In regard to a patch put on by your Mr. Googins fo us on a crack in the steam chest of the h.p. cylinder of a 26"x54"x36" vertical engine, would say it has now been in use about 10 days, and is still tight under 160 lbs. pressure. The back of this patch was covered with No. 1 Smooth-On and drawn into place by heavy straps and allowed to set, and now has the appearance of having made a permanent job, thus saving the cost of a new steam chest.

Yours respectfully,
G. A. MERRILL,
Chief Engineer.

The place where the patch was put on is indicated by **B,** while the joints in which the gaskets were used are indicated by the letter **A.**

Certainly here is proof enough that Smooth-On products are money savers in the power plant—maybe you have a troublesome place in your own plant at the present time—try Smooth-On; it will remove the trouble.

But write anyhow for our new Instruction Book, which we will be pleased to send you Free.



Smooth-On Mfg. Co.

572-574 Communipaw Avenue

Jersey City, N. J., U. S. A.

Chicago, 61 N. Jefferson Street San Francisco, 94 Market Street
England, 8 White Street, Moorfields, London, E. C.

POWER

Vol. 35 NEW YORK, JANUARY 16, 1912 No. 3

Once there was a man belonging to a certain engineers' organization whom his fellows came to look upon as a sort of mine of information, both general and specific.

Whenever you put a question to him concerning some phase of "power-planting," if he couldn't answer you offhand he would say, "I'll look it up." And sure enough, he would. The next time he saw you he would have a whole bunch of interesting facts and figures to give you.

Whenever the association listened to a lecture or to the reading of a paper, this man always came primed with intelligent questions to ask and, usually, he had a few illuminating remarks to make as well. And let us tell you, friend, the ability to ask intelligent questions usually results from a fairly earnest study of the subject in question.

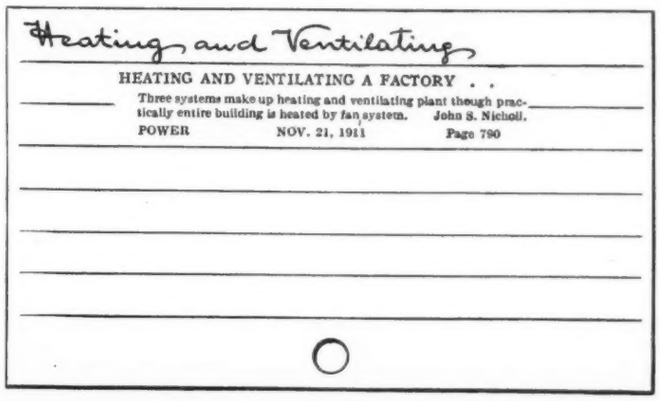
Well, one day, as was inevitable, he was asked how he did it and in reply he said:

"I am a collector, not of stamps, old coins or first editions, understand me, but of facts, figures and fancies concerning the science of power generation and transmission, the which affords me bread and butter.

"Any article I see in a magazine or journal which seems worth preserving for reference after I have read it, I clip out and file away.

"I started in with one small cardboard file or transfer box. I had no index. The box contained a set of stiff paper separator sheets, each with a letter of the alphabet marked on it at the edge. I filed each article under the initial letter of the most suggestive word in the title. It was no time before I had that box filled. Then I filled another and still another. By this time the lack of an adequate index began to be a bit of a hardship and I decided to use a vertical filing cabinet and a card-index and cross-reference system. Then, not only could I index what clippings I actually had in my file but I could also index many articles of which I could not or did not wish to make clippings."

POWER, beginning with this issue, will arrange the "Outline of Topics" page so that the title, the brief synopsis, the author's name, the date of issue and the page number of each article will form a neat paragraph that may be clipped out and pasted onto an index card in the manner shown herewith. All that will then remain to be done is to write the general heading on the first line and place the card in its proper place in the index.


Heating and Ventilating

HEATING AND VENTILATING A FACTORY . .

Three systems make up heating and ventilating plant though practically entire building is heated by fan system. John S. Nicholl.

POWER NOV. 21, 1911 Page 780

We know that this new arrangement will be welcomed by those who now maintain a reference index and we hope that it will encourage others to start the construction of one.

High Vacuum, Reciprocating Engines

By H. Fothergill

An argument for the use of a high vacuum with reciprocating engines, showing how it may be employed to advantage by properly designing the exhaust ports and passages of the low-pressure cylinder. Tests are cited to substantiate this.

Considerable interest is afforded by a paper by K. Heilmann, of Magdeburg, Germany, with reference to the efficiency of reciprocating engines, which was abstracted in the Oct. 31 issue of POWER. In this much attention has been given both theoretically and by practical experiment to the effect of steam superheating and cylinder condensation.

Articles are constantly appearing which deal with the subject both with reference to steam superheating and cylinder condensation, but the question of vacuum as affecting steam consumption and increased horsepower has, however, received only casual attention and considerable error in the conclusions arrived at is likely to be the result unless the matter be thoroughly investigated.

It is held by many engineers that any augmentation in the condenser vacuum above 24 or 25 in. does not result in such an increase in steam economy as would fully justify the extra initial cost of installing a condensing plant suitable for the higher vacuum, and therefore it has become more or less standard practice with reciprocating engines, to design the condensing plant for a vacuum of about 25 inches.

The general acceptance of a low vacuum as being best suited for reciprocating engines has no doubt been arrived at from results previously obtained by steam-consumption trials at varying vacuums. Fig. 1 illustrates a typical example of the effect of vacuum on the steam consumption of compound and triple-expansion engines having cylinders of ordinary design. In both cases the rate of decrease in steam consumption rapidly falls off toward the higher vacuum; in fact, the curve at the higher vacuum approaches closely to the horizontal.

In the triple-expansion engine it will be seen that from 20 to 26 in. the total economy is 1.27 lb., equal to 1.87 per cent. per inch of vacuum over this range; while from 26 to 29 in. the total economy is 0.08 lb., representing 0.23 per cent. of improvement per inch of vacuum, a very slight gain as compared with the economy obtained over the lower range. In the compound engine the gain at the higher vacuums is even less, due, of course, to the lower number of expansions and to the greater cylinder condensation.

From such observations as these it would naturally appear that the production of the higher vacuum in order to realize the slight increase in economy is not justifiable, and engineers were unanimously of the opinion that for reciprocating engines the greatest overall economy in the engine room could be obtained with a vacuum in the neighborhood of 25 inches.

There is no reason, though, why the curves should not continue in a downward direction and a higher economy be obtained provided the low-pressure cylinder be suitably designed to respond to the higher vacuum, and in overlooking this fact engineers have arrived at the false conclusion that the lower vacuum is the most economical.

The true effect of high vacuum on the steam consumption and increased horse-

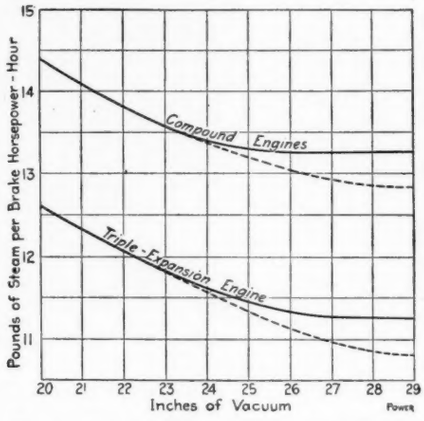


FIG. 1. EFFECT OF VACUUM UPON STEAM CONSUMPTION

power of reciprocating engines has perhaps for the first time been most thoroughly dealt with by D. B. Morison, who has proved beyond doubt that the increase in steam economy due to the higher vacuum fully justifies its use, provided the ports and passages of the low-pressure cylinder are of such proportions as will permit of the unrestricted flow of steam into the condenser.

In considering the ports and passages of an ordinary low-pressure cylinder, the exhaust areas are such as to produce a high velocity of steam when the pressure on the exhaust side of the port is lower than that on the piston side, the velocity, of course, being dependent upon the quantity of steam passing per square inch of port area. Steam turbines may be constructed so that a high exhaust velocity occurs only with exceedingly high vacuums, and, therefore, the difference in pressure between the condenser vacuum and the vacuum in the low-pressure section of the turbine under normal conditions is very slight and the turbine fully responds to the higher vacuum. Hence, reducing the exhaust velocity and minimizing the pressure difference between the condenser and the low-pressure cylinder in reciprocating engines is a problem worthy of careful consideration, as the quantity of heat available for doing useful work in the engines is dependent upon the pressure on the exhaust side of the ports.

Mr. Heilmann found from tests carried out at the works of the manufacturers of the "locomobile" engine at Magdeburg that the efficiency of the engine reached its highest value with about 80 per cent. vacuum. With higher vacuums, the losses were increased, due to the throttling effect between the low-pressure cylinder and the condenser, and yet apparently no attempt was made to avoid this by constructing the ports and passages of the low-pressure cylinder so as to minimize the throttling effect and obtain the full possible benefits resulting from the higher vacuum.

Careful experiments have recently been conducted by R. L. Weighton in order to arrive at a definite conclusion as to the economy derivable from high vacuums, and a series of steam-consumption tests were made with both triple- and quadruple-expansion reciprocating engines at varying vacuums. The first set of tests was recorded from the engines when fitted with low-pressure cylinders of ordinary design. Before taking the second readings the low-pressure cylinder was removed and a new cylinder having specially designed ports and passages of large cross-sectional area was fitted in its place.

The results obtained from the first readings were represented by curves similar to those shown in Fig. 1, while the results obtained from the second readings with the new low-pressure cylinder having enlarged ports showed a uniform increase in steam economy up to the highest vacuum carried in the condenser. In the case of quadruple-expansion engines, the saving in steam between 25 and 28¼ in. vacuum was 5 per cent. and in triple-expansion engines 4 per cent.; the actual results obtained were as follows:

GAIN FROM 25 TO 28¼ IN. VACUUM

	Saving in Steam per B.hp., Per Cent.	Increase in B.hp., Per Cent.
Quadruple-expansion.	5.1	5.9
Triple-expansion	4.2	5.0

The reason for the gain in power being slightly greater than the gain in economy is because the higher vacuums entail a slight increase in steam consumption per revolution. There is therefore no doubt that had the engines from which the results shown in Fig. 1 were obtained, been fitted with low-pressure cylinders having enlarged ports and passages, the steam consumption at the higher vacuums would have been considerably reduced, as indicated by the dotted lines.

The next question to consider is the cost of obtaining this increased economy and how it compares with the actual saving effected. It has been stated that the expense of increasing the cross-sectional area of the ports and passages of the low-pressure cylinder adds to the first cost of the engines, but such is not the case, however, and it has been proved that the dimensions of the ports and passages necessary to permit an economical utilization of vacuums up to even 29 in. are moderate and not at all difficult to attain in practical designing, nor do they add appreciably to either the bulk, weight, friction or first cost of the engines.

A high vacuum is, in general, applicable to all types of reciprocating engines, maximum economy being obtained in large slow-speed engines with the ports of such dimensions as to permit the highest vacuum to produce such a diminution of pressure in the low-pressure cylinder as will make such a vacuum exceedingly advantageous. In small high-speed engines, it is not generally advisable to aim at the utilization of extreme vacuums, as the effect of increasing the ports has also the effect of increasing the clearance space, but even with moderately high vacuums the high thermal efficiency of this type of engine enables excellent economy to be obtained.

The largest field for a high vacuum in connection with reciprocating engines appears to be in the design of triple- and quadruple-expansion marine engines and it is in this direction that the greatest headway has been made; in fact, it is now becoming the recognized practice with British engineers to design engines upon this principle. A typical example of high-vacuum triple-expansion engines as constructed by Messrs. Richardsons, Westgarth & Co., Ltd., Hartlepool, England, is illustrated in Fig. 2, which represents a back view of the engine, showing the condenser and pumps. It will be noted that the exhaust pipe is of large diameter and the space occupied by the condenser is relatively small.

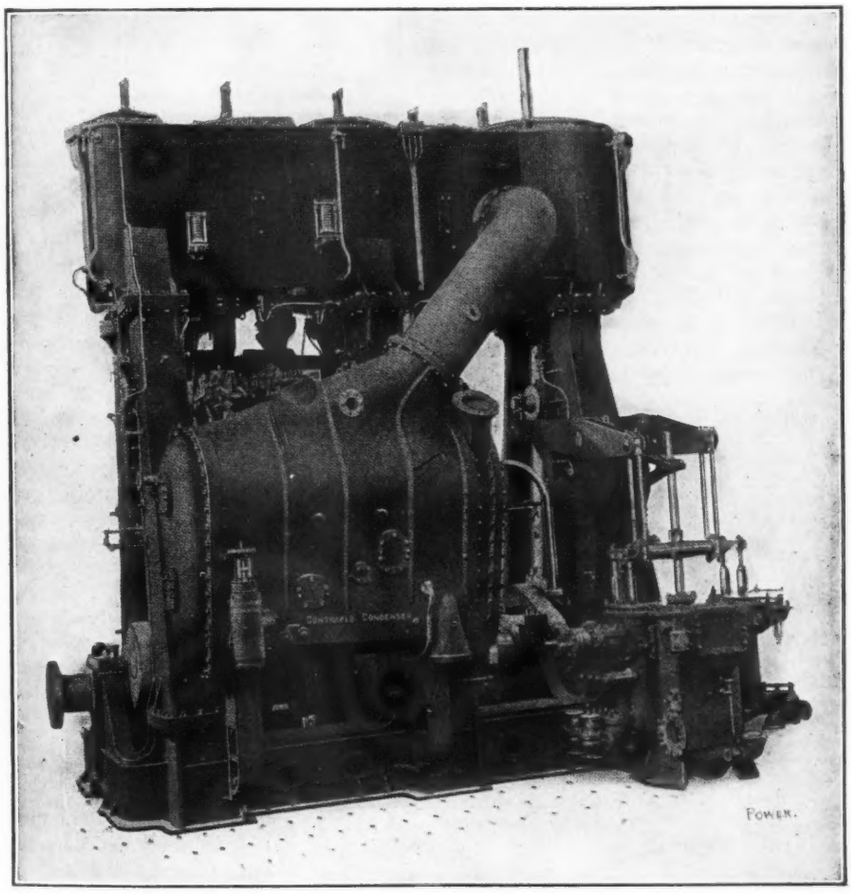


FIG. 2. TRIPLE EXPANSION MARINE ENGINE DESIGNED FOR HIGH VACUUM

The air-withdrawing capacity of any reciprocating air pump of a given size depends on the difference between the vacuum that can be produced in the pump barrel on its suction stroke and that of the vacuum in the condenser. But if water of condensation enters the pump at a temperature corresponding to the vacuum in the condenser, it would obviously boil as soon as the pump bucket commenced its suction stroke, and the resultant vapor, by filling the barrel, would impair the inflow of air from the condenser. If, on the other hand, the water entering the pump were so cold that it did not boil during any portion of the vacuum-producing stroke of the air pump, then the vacuum produced in the barrel would be much higher than in the condenser and the flow of air into the pump would be a maximum. Therefore, an air pump can be rendered very flexible in air-withdrawing capacity by the temperature, and if there are means for controlling this, then the air-withdrawing capacity of a single pump can be regulated in accordance with the quantity of air to be withdrawn and the vacuum required.

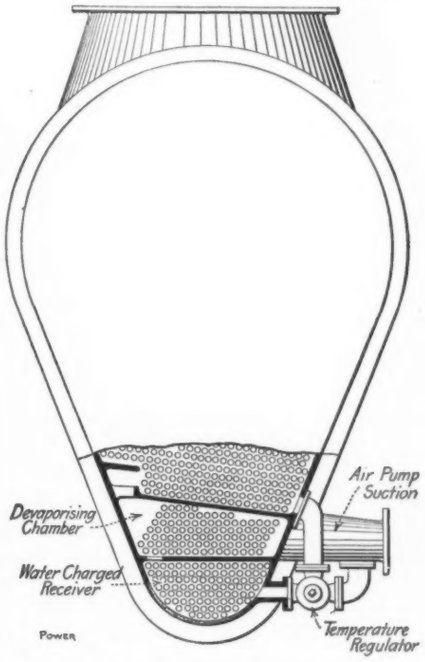


FIG. 3. CONTRAFLOW CONDENSER WITH TEMPERATURE REGULATOR

The condenser illustrated in Fig. 3 contains a receiver divided off at its base which is always completely filled with water of condensation. At a distance above this water receiver is a diaphragm which catches the water of condensation formed in the condensing chamber above it.

There is a pipe connecting the top of the water-collecting diaphragm and the water receiver, and in this pipe there is inserted a two-way cock or valve, one way leading to the air-pump suction pipe and the other to the water receiver. If there is a clear way between the water-

collecting diaphragm and the water receiver, all the water of condensation passes through the receiver and is reduced in temperature before it passes into the air pump. If, on the other hand, there is a clear way between the collecting diaphragm and the pump, all the water of condensation passes at a maximum temperature into the pump. The temperature of the pump, and therefore its air-withdrawing capacity, is under complete control by the partial or the full use of the temperature regulator.

Experience has shown that by the use of this temperature-regulating device for cooling the whole or a portion of the water before passing into the air pump, a low vacuum in the tropics can be raised by from 1½ to 3 in., and often more; at the same time the air-pump discharge water is kept at the highest temperature consistent with the maintenance of the highest available vacuum in the condenser.

It has been advanced by some engineers that any increase in economy on a steamship resulting from a high vacuum is impaired by the loss of heat units due to the reduced temperature of the feed water. Such a statement can apply only to out-of-date steamships. According to modern practice, the feed water in a steamship is heated to pumping limits by the available exhaust steam from the auxiliary engines, which is generally found to be more than sufficient for that purpose. The temperature of the feed water is therefore independent of the temperature at which it passes through the air pump.

It is only natural, however, when a considerable gain is effected in one quarter, to look for a possible loss in another quarter, and one might be inclined to think that the pumping power required for circulating the extra condensing water through the condenser to obtain the higher vacuum would be abnormally high, but by simple calculation it can be shown that the increase in pumping power is so small compared with the increase in the horsepower of the main engines that it is unworthy of consideration.

A Boiler Room Argument

By F. Webster

"Look out for your clothes!" I cautioned banteringly, as Denny stood near the open furnace door while the induced-draft fan tugged at the smoke flue. The door clanged shut, he hooked the hoe into the lattice braces of the nearby roof post and slammed the handle against the foot of it.

"Thim air-blowed, man-operated furnaces make me lose everything but me appetite," he declared, turning his grimy face square at me. "T'row the wind-sucker outfit into the river. Thin put in a steam blower, an' ther fires can be forced wid half ther labor an' widout cost fer fuel."

"That's going some," I said; "the agent who put in that induced-draft outfit promised to operate it on only 3 per cent. of the steam, or with 85 per cent. of the steam that would be used by a jet blower. If a steam blower will be better than a fan, I am here to be shown."

Denny heaved a heavy sigh at my ignorance, and he turned to the patent weighing chute. After dropping a ton of dirt onto the floor he drew forth a copy of the *Stokers' Journal* from his hip pocket.

"This theoury of blowin' cold air into ther ashpit, or of sucking the smoke out of the breeching is all clinker," he contemptuously remarked, as he turned over the advertising pages of the *Journal*. "Fans take nearer tin per cent. than t'ree per cent. of ther steam, no matter what agents may say. As it takes more draft to burn dirt than it does to burn lump coal, it is roight here that ther agents for all sorts ov air machines get in their wurruk on ther boss; whin they learn that he is thinkin' ov changin' over so as ter use a cheaper fuel, or is hot-foot for makin' a savin', they come whinin' around like coyotes that smell dead horse."

Denny had been a cowboy before he entered the engineering field and his mind frequently wandered to the days of his stunts in the sagebrush. "Takin' fer granted that somethin' must be used ter force a dirt foire, what sort of a hitch should it be?" he continued. "I say that steam-jet blowers beat forced-draft fans.

"Air is four-fifths waste. Ther nitrogen fills up ther space, an' does nothin' fer combustion itself; besoides, it hinders ther oxygen, which is one-fifth of ther air, from gettin' at ther foire and ther burnt gases from gettin' out ov ther stack. A blast ov air widout steam in the ashpit will make clinkers, an' anny foire that clinkers will not get all ther heat out ov ther coal. Tryin' ter be eccynomical ther fireman lets a jet ov exhaust steam from some ov ther ingines into ther ashpit; or, fer convanyance, ther steam may be piped into ther air duct at some distance from ther furnace. In ayther case, he don't get much steam into ther foire at all, but he has ter rowl up his trousers ter keep out ov ther watther that comes onto ther floor. Ther cold air condenses ther exhaust steam an' afther a whoile ther pit overflows like anny ol' irrigation ditch. But jist use hoighly sooper-heated steam direc'ly on ther spot an' ye have a double cinch on anny furnace."

"Steam has to come out of the boiler, and hot talk will not superheat it," I remarked. "Water is not a fuel, and putting superheated steam into the fire may prevent clinkers, but where is the economy of using live steam for blowing?"

"They all talk that way, avan afther they've bin bit," Denny replied knowingly. "This is because they don't know sooper-heated steam in furnace operashun. Ye see," he continued, reading from his paper, "ther sooper-heated steam does ther blowin' an' it also gits into ther foire. There ther steam gits decomposed by ther high heat inter its component gases, hydrogen and oxygen. Ther hydrogen passes on into ther combustion chamber where it moight unite wid ther oxygen of ther air an', burnin', forms watther. Its burnin' gives back ther heat that was absorbed from ther foire to decompose ther sooper-heated steam, an' this returned heat affects ther boiler at ther rear ov ther ordinary hot spot. Thus ther schame extinds ther furnace effect. Ther watther vapor from ther burned hydrogen passes up ther stack wid ther other waste gases. Ther oxygen from ther decomposed steam aids in burnin' ther coal, an' ther gas formed by ther union ov wan atom ov oxygen wid wan atom ov carbon will take up wan more atom ov oxygen in ther hot area where ther hydrogen is burnin' an' thus add greatly to ther furnace heat. The sooper-heated steam jet can be used as a blower ov wan hunderd per cint. efficiency."

"Whew! Perpetual motion in the boiler furnace, and the Patent Office only 500 miles away!" I exclaimed. Similar efficiencies are common in stock prospectuses, especially those originating in Boston and Philadelphia. Taking heat from the burning coal to decompose water, or live steam, and then getting a return of the heat by burning the hydrogen at another location under the boiler, is a scheme that makes one's head dizzy. I suggested that, before he spread his secret broadcast, he condense the steam from the jet blower and weight it; also, that he find out the nature of the gases that went up the stack.

"I'll admit," Denny interjected, "that ther steam-jet blower will use as much or more steam as ther fan, but it can do so widout anny operatin' cost, an' ther whole outfit nade not cost more than a dozen dollars. Wid ther sooper-heated steam jet ther boiler gits heat not only from ther burnin' coal directly but also from ther burnin' hydrogen, as it recombines wid ther oxygen farther back in ther furnace."

The whistle blew and I ducked with this parting shot: "What'll you give me per ton for extra fine water for fuel?"

I went down the street, musing on what would happen if one ever got blowers of 100 per cent. efficiency. Then there came to mind the philosophy of the old farmer who was seen putting a dead snake in each hill of corn for a fertilizer. "Wa'll it's jest this way," he explained when questioned, "snakes make corn, corn makes whisky, an' whisky makes snakes."

Smoke Prevention with Steam Jets

By J. A. Switzer

The introduction of a system of smoke consumers, consisting of automatically controlled steam jets over the fire, not only reduced the smoke about 90 per cent. but also greatly increased the plant efficiency. The coal used was high in volatile matter.

KNOXVILLE RY. & LIGHT CO.

The boiler equipment of the Knoxville Ry. & Light Co. consists of three 300-hp. Stirling and five 600-hp. Babcock & Wilcox boilers; the latter are superheating and all are hand-fired. A system of forced draft is installed for occasional use, but ordinarily natural draft suffices. There are two chimneys cross connected; that is, the breeching is continuous from one end of the battery to the other. The plant operates condensing and there is the usual complement of boiler pumps, feed-water heaters, etc. All eight boilers have been equipped with the smoke consumers, and Fig. 1 shows one of the larger boilers thus equipped. In Figs. 2 and 3 are shown respectively the average appearance of the stacks before and after installing the consumers.

Ordinarily two of the 600-hp. boilers serve to carry the night load, three the day load and four the peak load; but on holidays and special occasions the entire battery is taxed to furnish the requisite power. Coal is purchased on the B.t.u. basis and is regularly analyzed.

Smoke consumers were put in under a contract making the following guarantees: First, to abate 90 per cent. of the smoke; second, to increase the capacity of the plant 10 per cent. or more; third, to reduce the accumulation of soot on the tubes 50 per cent., and, fourth, to effect an actual saving of 10 per cent. of the fuel. These guarantees were to be determined, first, by means of two evaporative tests, and, second, by a comparison of the coal consumption per kilowatt-hour during the month next succeeding that in which the installation was made with the coal consumption of any month during the year 1910. The contract further specified that should the equipment fail to meet the guarantee as judged by either of these tests, or should it not prove entirely acceptable to the company, it was to be removed and all charges were to be cancelled.

The smoke-consuming apparatus consists of a steam line terminating in jets placed just inside the special fire doors which are fitted with dashpots connected by a lever system to automatically controlled valves. The arrangement is such that when a door is opened for stoking the steam is automatically turned on and discharged into the combustion chamber. When the door is closed after firing, the steam continues to blow, and dampers on the door are held open for a period of three or four minutes; then the motion of the dashpot slowly closes the dampers and throttles the steam.

The action in abating smoke is as follows: When fresh coal is fired upon the hot fuel bed, the combustible volatile matter begins instantly to distill in great quantity. For the complete combustion of this gas an increased supply of air is immediately required. The steam jets create the draft and the open dampers furnish the avenue for the admission of this supply of air. But in addition to fulfilling this function, the jets by a swirling action serve to bring about a complete mixing of the air and combustible gas, thus insuring practically complete combustion before the burning gases can come into contact with the heating surfaces.

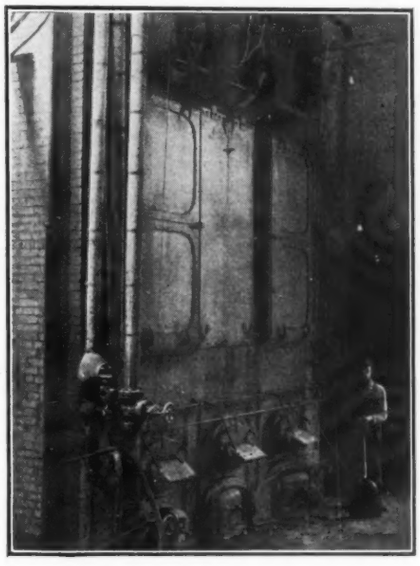


FIG. 1. SHOWING SMOKE CONSUMERS APPLIED TO BOILER FRONT

EVAPORATIVE TESTS

These tests were each of 11 hours' duration and were conducted by the writer with the assistance of engineering students of the University of Tennessee, the station engineer participating.

METHODS EMPLOYED

Coal is distributed to the boilers by a bucket conveyor and was weighed in this bucket on a special-test platform scale. The weights were calibrated on the ground and were found to be correct to within less than one-tenth of 1 per cent. The alternate method of running the test was employed.

The feed water was measured by means of a 3-in. Venturi meter, and observations were made every minute throughout the test. The meter was calibrated with great care and the probable error of feed-water measurement did not exceed 1 per cent. At the end of each test the water in each of the gage glasses was brought back to the string marking its level at the beginning.

Coal was sampled at the time of weighing, and determinations of the heat value were made with a Parr calorimeter.

Just prior to installing the steam-jet apparatus the company had equipped its boilers with soot blowers. In order to eliminate any influence which the use of these blowers might have upon the performance of the plant during the tests, it was agreed that the blowers should not be used for 36 hours preceding each test.

The indicating wattmeters were read every minute throughout both tests. The readings were plotted upon cross-section paper, and the curves integrated with a planimeter. In order to guard against personal error, instantaneous readings were made. At the beginning and end of each test the watt-hour meters were also read; but since these instruments cannot be read closer than to the nearest 1000 kw.-hours, dependence could not be put upon them. It is interesting to note, however, that in both tests the agreement between the two sets of instruments was closer than the latter could be read, being in both tests within about 800 kw.-hours; and in both tests the variance was in the same direction.

SMOKE OBSERVATIONS

Smoke observations were carried on by comparison with the Ringelmann chart, and were made every minute during the tests. From these observations the charts were plotted as shown in Fig. 4. However, a comparison of the two charts utterly fails to indicate the degree of smoke abatement accomplished. The Ringelmann method of observation takes account only of the color of the smoke and not at all of its volume. While it is true that since the installation was made the smoke occasionally reached a blackness of No. 5 for short intervals of time, its volume during these intervals is as nothing compared to that which was formerly habitual with the smoke. On

the day of the first test, smoke of No. 5 blackness issued forth 72 per cent. of the time; No. 4, 23 per cent.; No. 3, 3 per cent., and No. 2, 2 per cent. Not once during the 11 hours of the first test did the smoke from either stack drop below No. 2. During 95 per cent. of the time prior to the installation of the smoke consumers a volume of smoke was generated which now is not equalled for 2 per cent. of the time; and, while the exact percentage of abatement accomplished is purely a matter of individual judgment, it is certain that 90 per cent. of the smoke has been stopped.

The Evaporative Tests

As far as possible, the operating characteristics of the plant were maintained alike for the two tests, except for one particular. It had been customary to carry the day load on three of the 600-hp. boilers, and at about 3 p.m. to cut in a fourth to meet the approaching peak load. The increase of boiler capacity brought about by the new equipment permits postponing cutting in the fourth boiler until after 5:30 p.m. If the duration of the tests had been 24 hours, it is probable that the comparative showing would not be essentially changed, since a like improvement has been made in the time of changing from the night to the day load in the early morning.

TEST DATA AT PLANT OF KNOXVILLE RY. & LIGHT CO.

	First test	Second test
Date of test	March 29	May 5
Duration of test, hours	11	11
Boilers fired, Babcock & Wilcox (No. 1 for 1 hour, Nos. 2, 3, 8)	1	2, 3, 8
Grate surface, square feet	270.0*	262.5
Heating surface, square feet	14,964	14,520
Ratio heating to grate surface	55.3:1	55.3:1
Steam pressure, pounds gage	157	160
Draft gage near stack, inches of water	0.32	0.29
External air, degrees Fahrenheit	45	65
Boiler room, degrees Fahrenheit	64	72
Feed water, degrees Fahrenheit	186	190
Steam, degrees Fahrenheit	409.3	433
Fuel		
Kind of fuel	Jellico nut and slack	Jellico nut and slack
Size of coal		
Moisture, per cent	2.77	2.96
Ash, per cent	10.6	14.1
Heat value per pound of coal, B.t.u.	13,528	13,091
Heat value per pound of combustible, B.t.u.	15,150	15,320
Total coal consumed, pounds	74,213	56,700
Dry coal consumed, pounds	72,158	55,008
Total ash dry, pounds	7,817	7,970
Total combustible, pounds	64,341	47,038
Total Water		
Total weight of water used, pounds	557,850	546,400
Total evaporation dry steam, pounds	557,850	546,400
Superheat, degrees Fahrenheit	40.7	63.0
Factor of evaporation	1.102	1.104
Equivalent evaporation from and at 212 degrees	614,750	603,220
Economic Evaporation		
Actual evaporation per pound of dry coal, pounds	7.73	9.93
Equivalent evaporation from and at 212 degrees per pound of dry coal, pounds	8.52	10.96
Equivalent useful evaporation per pound of dry coal (deducting steam used for jets), lb.	8.52	10.52
Actual evaporation per pound of combustible, pounds	8.69	11.62
Equivalent evaporation per pound of combustible, pounds	9.58	12.83
Equivalent useful evaporation per pound, pounds	9.58	12.23
Horsepower		
On basis 34½ pounds equivalent evaporation per hour	1,615	1,590
Corrected for steam used by jets		1,526
Builders' rating	1,854	1,800
Ratio, commercial to builders' rating	87.0	85.0
Electrical Output		
Kilowatt-hours	16,950	15,925
Kilowatts per hour	1,540	1,450
Efficiencies		
Heat supplied per pound of dry coal, B.t.u.	13,528	13,091
Heat absorbed per pound of dry coal, B.t.u.	8,228	10,160
Efficiency of boiler, per cent	61.1	77.7
Efficiency of boiler and grate	60.8	77.8
Overall efficiency of plant, per cent	5.94	7.54
Economic Performances of Plant		
Coal per kilowatt-hour, pounds	4.38	3.56
B.t.u. per kilowatt-hour, pounds	57,600	45,560

*As No. 1 boiler was feeding steam into the line for only one hour, or $\frac{1}{11}$ of the time, the grate surface of three boilers, 262.5 square feet for 10 hours, and 262.5 square feet plus 87.5 square feet (boiler No. 1) for one hour, is taken as equivalent to 262.5, plus $\frac{1}{11}$ of 87.5, or 270 square feet, for eleven hours. The same applies to the heating surface.

Station Records

The station records are as follows:

Date	Pounds of Coal	Total Kilowatt-hours Generated	Pounds of Coal per Kilowatt-hour
Jan., 1910	3,958,000	960,948	4.12
Feb., 1910	3,646,000	826,604	4.42
Mar., 1910	3,680,000	876,322	4.20
Apr., 1910	3,576,000	854,510	4.18
May, 1910	3,816,000	860,368	4.43
June, 1910	3,506,000	855,756	4.09
July, 1910	3,734,000	879,700	4.24
Aug., 1910	3,788,000	908,640	4.16
Sept. 1910	4,648,000	1,086,640	4.27
Oct., 1910	4,746,000	1,084,834	4.37
Nov., 1910	4,354,000	1,054,529	4.13
Dec., 1910	4,864,000	1,141,964	4.26
Average for 1910			4.24
May, 1911	3,356,000	939,000	3.57

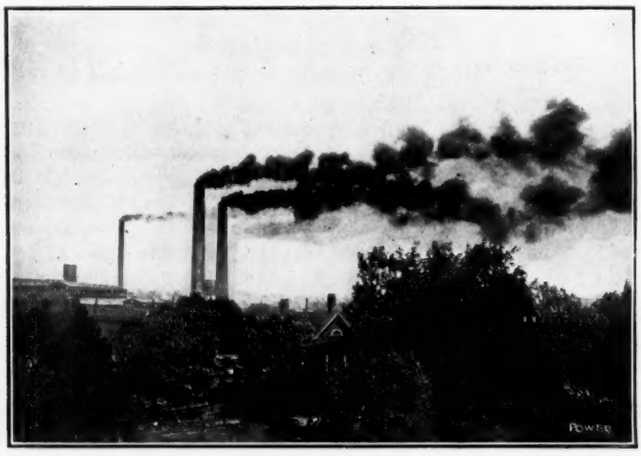


Fig. 2. Usual Appearance of Knoxville Railway & Light Co.'s Stacks before Installing Jets

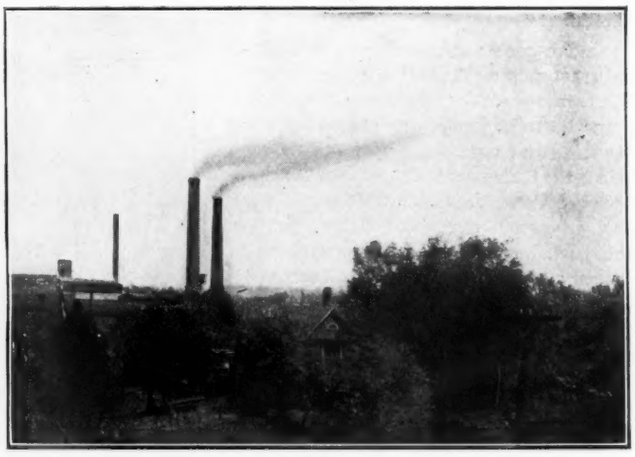


Fig. 3. Average Appearance of Stacks Since Installation of Jets

In analyzing these figures it is of interest to note first the close agreement between the coal consumed during the second evaporative test, 3.56 lb. per kilowatt-hour and that consumed during the entire month of May, 3.57 lb. per kilowatt-hour.

In accordance with the terms of the contract, the saving effected could justly be calculated by comparison with the fuel consumption for May, 1910. On this basis the saving would appear to be 19.4 per cent. However, this is not a fair comparison, since the operating characteristics of the plant in May, 1910, were not as favorable as during May, 1911. Comparing the fuel consumption for May, 1911, with the average for the year 1910, the saving figures 15.8 per

cent., and this might well be regarded as a fair comparison. For the sake of finding a perfectly impartial basis of comparison, however, the complete station records were searched with a view to selecting a month during which the operating characteristics were identical with those of May, 1911. The records for May, 1909, meet these conditions, 3,410,000 lb. of coal being burned and 315,400 kw.-hours generated, giving a coal consumption for the month of 4.18 lb. per kilowatt-hour. This yields as a final figure a saving of 14.6 per cent. A comparison of the average cost for the time which has now elapsed since installing the smoke consumers, with the average for the previous 16 months, strikingly confirms this figure.

It remains to reconcile this 14.6 per cent. with the 20.9 per cent. saving apparently shown by the two evaporative tests. Before the second test the soot blowers had not been used for 36 hours. In spite of this fact, the boiler performance was as good as that shown for the rest of the month, when the tubes were blown twice daily. This is so because the steam jets themselves kept the tubes clean. Before the first test the soot blowers had not been used for 36 hours. The fact that the boiler performance on this day was below the average performance for 1910 proves simply that the tubes were badly coated. Hence the evaporative tests are of interest chiefly in that they bring out the service rendered by the smoke consumers in keeping the boiler tubes free from soot.

Results similar to the case just described were obtained with steam jets in the boilers of the Knoxville cotton mills.

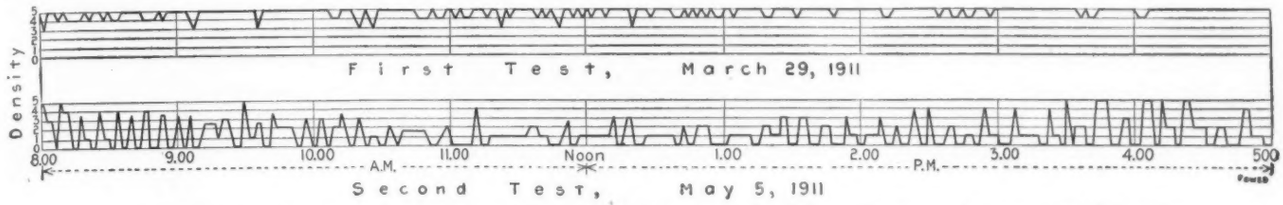


FIG. 4. RINGELMANN SMOKE CHARTS, MADE DURING TESTS AT KNOXVILLE RAILWAY & LIGHT CO.'S PLANT

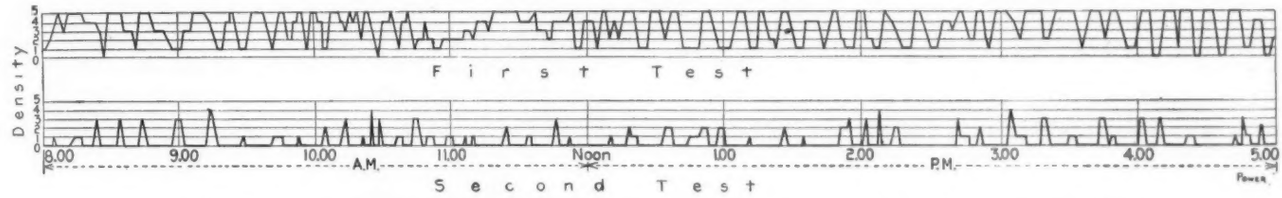


FIG. 5. RINGELMANN SMOKE CHARTS MADE DURING TESTS AT THE KNOXVILLE COTTON MILLS

KNOXVILLE COTTON MILLS

The boiler equipment of these mills consists of one 160-hp. Heine, one 200-hp. and three 150-hp. Stirling boilers, giving a total capacity of 810 b.hp. The contract for the smoke-consuming equipment was similar to that previously described; but the mills had no adequate record of their coal consumption.

The methods of the evaporative tests were the same as those used at the Knoxville Ry. & Light Co.'s plant.

Although the load carried by the plant is less than 550 b.hp., it has been the practice to carry the entire battery under steam, since with the quality of coal used steam could not otherwise be held. During the test with the consumers in operation, however, it was found an easy matter to carry the load with the 200-hp. boiler cut out, notwithstanding that poorer coal was used than for the first test.

The degree of smoke abatement secured was better than that in the first

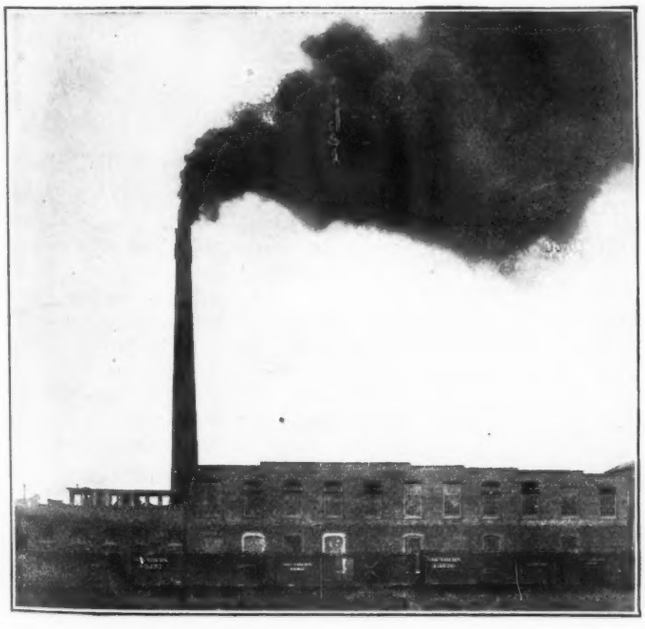


FIG. 6. KNOXVILLE MILLS 60 SECONDS AFTER FIRING; STEAM JETS NOT IN USE

FIG. 7. KNOXVILLE MILLS 60 SECONDS AFTER FIRING, WITH STEAM JETS IN OPERATION

case described. This is shown both by a comparison of the smoke charts, Fig. 5, and of the photographs of the chimney, Figs. 6 and 7. No. 5 smoke did not occur at all with the consumers operating, and No. 4 occurred but four times during the entire nine hours of the test. On the other hand, the fuel saving is somewhat less. Figured on the basis of the B.t.u. supplied per pound of water evaporated, the saving would appear to be 14.8 per cent., but allowing that 3 per cent. of the water evaporated was consumed by the steam jets themselves, the final calculation shows a saving of 11.5 per cent.

TEST AT KNOXVILLE COTTON MILLS

	First Trial	Second Trial
Duration of trial, hours	9	9
Number of boilers fired	5	4
Grate surface, square feet	175.5	131.5
Heating surface, square feet	779.0	579.0
Steam pressure, pounds gage	115	116
Draft at breeching, inches of water	0.17	0.19
External air, degrees Fahrenheit	82	85
Boiler room, degrees Fahrenheit	94	107
Feed water, degrees Fahrenheit	192	189
Steam, degrees Fahrenheit	337	347
Kind of coal	bituminous nut and slack	
Size of coal		
Moisture, per cent	2.47	2.88
Ash, per cent	11.2	12.7
Heat value, per pound of dry coal, B.t.u.	13,153	12,790
Heat value, per pound combustible, B.t.u.	14,850	14,650
Total coal consumed, pounds	20,313	18,188
Dry coal consumed, pounds	19,800	17,640
Total ash, pounds	2,305	2,340
Total combustible, pounds	17,495	15,325
Economic Evaporation		
Actual evaporation per pound of dry coal, pounds	7.35	8.85
Equivalent evaporation from and at 212 degrees, per pound of dry coal, pounds	8.20	9.42
Actual evaporation per pound of combustible	8.75	10.20
Equivalent evaporation from and at 212 degrees, per pound of combustible, pounds	9.27	10.85
Horsepower		
On basis 34½ pounds equivalent evaporation per hour	525	537
Builders' rating	810	610
Ratio of commercial to builders' rating, per cent	65	88
Efficiencies		
Heat generated per pound of dry coal	13,153	12,790
Heat absorbed per pound of dry coal	7,919	9,097
Efficiency of boiler and grate	60	71.2
B.t.u. per pound of water evaporated	1,747	1,489

From the results of these and other tests which the writer has had the opportunity of making, he feels that the utility of steam jets, when properly controlled, has been established beyond question. The earlier reports, which were not favorable to the use of steam jets, were based either on tests made with steam jets not automatically controlled or else on tests of plants in which coal low in volatile matter was burned. Hand-operated steam jets will never serve effectively to prevent excessive smoke and do so with the highest economy; nor will automatically controlled steam jets effect any such saving of fuel as here reported if used with low-volatile coals. But the amount of smoke produced by a coal, and consequently the need for equipment to abate the smoke, increases as the volatile content of the coal increases; and so in general it may be said that the worse the offense of a plant in respect to smoke production the greater is the hope of its ultimate reformation.

Why "Block" Stations Do Not Thrive

By Henry D. Jackson

The main reason is because central-station rates are lowered temporarily to stifle them. Another reason is the lack of belief as to the possibilities of the "block" station on the part of those whom it is intended to serve.

In the issue of Nov. 14 an editorial appeared entitled "The 'Block' Central Station," which mentioned a scheme often thought of, frequently tried and in many cases proving a decided success. Wonder was expressed in the editorial that there are not more such plants, even though they have not proved a success in many other places than New York City. It may be that the experience of the writer in a number of instances will explain why it has been found so difficult to organize and carry through a successful "block" plant.

In those large cities where the central station is firmly planted, it is difficult to carry through any "block"-plant scheme because of the required coöperation of so many interests. For instance, in a large block having many tenants, each tenant has a contract for lighting, and possibly for power, with the central station, the price of the power varying in accordance with the service rendered. The organizer of a "block" plant suggests to the tenants or owners the possibility of a central-power plant for furnishing light, power and heat, the whole to be worked out on a coöperative basis. Or he suggests that someone will install a plant from which will be furnished light, power and heat at a reasonable price; that the price will be much lower than that of the central station because the tenants can obtain a considerable return from the exhaust steam which will be supplied from the engines driving the generators using it for heating purposes. The organizer carefully studies the light, power and heat demands of the tenants or owners, and then proposes that each owner or tenant agree to pay for a proportionate part of the power, light and heat used, the porportion being first as regards the meter showings for the various purposes and then to the radiation used for the heat; or he shows how the individual who installs the plant can furnish light, power and heat at a low cost, giving these figures to the individuals interested.

At first the individuals are decidedly interested, and state that they will take hold and push the scheme. Almost immediately, however, one of them takes the matter up with the central-station people, telling them exactly what is proposed; thereupon the central station immediately lowers its rates for light and power to the figure proposed by the promoter—in some cases to an even lower figure—with the result that when the promoter next visits the individuals, he finds that they are unwilling to entertain his scheme.

The central station rarely makes a contract for more than a year under these conditions, the scheme fails and the price for power and light goes back to the normal figure.

Briefly, the reasons why the "block"-plant scheme has not always proved a success are:

1. The short-sightedness of the owners or lesses of the property in the block, who cannot see that the low figure given by the central station is only an expedient to choke off the "block" plant.

2. The apparent lack of belief of the individuals in the possibilities of power being furnished at any such price, largely owing to the representations of the central-station solicitors and also the individuals' lack of technical information.

3. The unfortunate condition of affairs that exists whereby the central stations are enabled to sell power below cost to large consumers and charge the excess up to the small ones.

This condition is frequently found in large cities, where the central stations are strongly intrenched. They make the claim that power during the day, and in very large quantities, costs them nothing but the operating expenses during this period, as the interest, maintenance and

depreciation on the machinery, buildings, etc., are paid for during the lighting load. This is true only to a very limited extent, because the lighting and the power load do overlap to such an extent that it is only reasonable and fair that a considerable portion of the fixed charges should be made on the power bill, and the lighting commission in fairness to all consumers should take this attitude.

In one instance which came to my notice in the suppression of a "block" plant by the central station there was a large establishment which supplied light for the entire block, power for its own service and steam from heating and manufacturing purposes. A very fair profit was made from the sale of light and heat. The central-station solicitor, to secure this large block, made a proposition to the owner, who was not a steam or electrical expert.

He was informed that the larger part of the steam used was required for driving the electrical apparatus and that he was not making the amount of money he thought he was; that if he would put in electric power at a price slightly lower than he figured it cost him, he would save a very considerable sum; that his heat was costing him the most money. The owner believed him, dismantled his plant and put in central-station power. Much to his surprise, after the first year's operation, he found that the total bill for heating, lighting and power was very nearly double what it had ever been, including, as he did, all of his fixed charges.

To the technical man the reason is clear. His heat, both for manufacturing and heating, was formerly provided by exhaust steam, and sufficient exhaust steam was at all times available from the operation of his engine, so that he was practically supplying his heat for nothing. He was getting a fair price for his electricity and made a profit on it. On the removal of his generators he still had to supply the heat. The boiler capacity was the same as before, requiring the same amount of coal and the same amount of labor. The only difference was that he was not paying fixed charges on the difference between the price he paid for his generating apparatus and the price at which he sold it, and he was paying a price very nearly equal to what his electricity cost him in his own plant for what he purchased from the central station.

The remainder of the people in this block were worse off, because they got a contract for only one year, whereas the owner got a contract for ten years. This arrangement doubled the price of electricity at the end of the first year and the second year doubled again, so that they were very large losers by the deal. It is possible that under the conditions a "block" plant may again be installed in this block under a different owner, or perhaps the former owner will install his plant and continue to pay to the central station the present price for electricity. Even under these conditions there is a possibility of his making a saving, although the power company manages to hold him to the contract.

In some cases the central-station managers have seen the opportunities in the block plants, and have leased or bought space, installed apparatus and made arrangements to furnish electric power and heating to the people in the block. By this arrangement they are enabled to make a very comfortable saving over the price of power as generated from their own station and still hold up the price to the tenant. The saving is made because the plant is operated practically only during the winter months, when the peak load on the plant is excessive, and enables them to reduce the peak load, and as the heat of the exhaust steam is paid for, their operating cost can be lowered. In the summer time the plant need not be operated as the peak loads are practically noncoincident and the central station can very readily take care of all the load without marked peaks or excessive apparatus.

This system, if carried to its limit, would practically do away with the central station except that of comparatively small size. It would, however, soon result in the installation of block systems by the building owners or in a coöperative arrangement between building owners, and this is, in my opinion, the only reason why the central stations do not take it up more fully.

Peat

The results of an investigation that was undertaken to determine whether peat, a fuel widely used in some countries, could be serviceable in the United States are contained in a bulletin just published by the Bureau of Mines. Its author, Charles A. Davis, the peat expert of the bureau, gives an exhaustive review of the entire problem, both in this country and in Europe, and draws the conclusion that the peat beds of this country are a great and neglected resource, which, when fully developed, will add to the national wealth no inconsiderable quantity of good fuel and of raw material for important arts and manufactures.

Mr. Davis declares that the difficulties that have always been encountered in utilizing peat for fuel are due to the fact that in its natural state peat contains only about 10 per cent. of combustible matter, the remaining 90 per cent., more or less being water. He also says that in the last few years, more than $1,000,000 has been spent in erecting plants and in experimenting with peat, and that these efforts were unsuccessful.

"Because the closing of larger plants before they had reached a stage of demonstrated success was so general," says Mr. Davis, "more conservative developments have been planned for making a thorough trial of the material in favorably situated places under American conditions of production and fuel supply."

Mr. Davis estimates that there are more than 11,000 square miles of land in the United States having peat deposits of good quality; that these deposits contain 12,888,500,000 tons of peat with a value of more than thirty-eight billion dollars, enough peat to furnish heat and power for the entire country for many years.

The author is of the opinion that there will soon be a demand for peat as a fuel, at the same time he gives the following warning: "The foundation of all successful development and growth of peat industries in the United States must be a thorough scientific study of the occurrence, nature, qualities and peculiarities of peat itself and a careful and honest investigation of the status of these industries in the European countries in which they have reached self-supporting existence.

"It is an exceedingly interesting coincidence and a most important economic consideration that the regions where peat is most abundant are relatively remote from the coal fields, the only exception being the overlapping of peat and coal in Michigan. When one also notes that the more Northern states, in which fuel is most needed, and the parts of the Southern states where other kinds of fuel are not readily available, are rich in peat, it seems strange that a more careful examination into the possibilities of our peat resources has not been made, because potentially they have large value and great possibilities.

"Peat fuel may be said to be especially useful for certain purposes for which wood was formerly in general use and for which coal has not yet been altogether successfully introduced, such as brick and other forms of ceramic firing and lime burning. It appears to reach its highest value, however, as a source of producer gas in properly constructed gas producers.

"No quantity of peat fuel of any type sufficient to prove its value has yet been produced in the United States; until this has been done, although the outlook and European experience warrant further investigation of its possible uses and value, no final conclusions as to the commercial value of American peat as compared with coal can be reached."

To remove varnish, paint, tar or lacquer, or to restore a hard paint brush, the following mixture is recommended by D. L. Fagnan, of New York City: 4 oz. benzol, 3 oz. fusel oil, mix and shake well, then add 1 oz. of alcohol. This mixture will remove varnish in 10 min. and will soften a hard brush when soaked for 1 hr.

Application of Prof. Bone's Boiler

A boiler 10 ft. in diameter and 4 ft. long, capable of evaporating 5,500 lb. of water per hour, has recently been constructed for the Skinningrove Iron Co.

This boiler is similar in design to the experimental one with which an evaporation of 21 lb. per square foot of heating surface was obtained.

The experiments of Prof. Bone, of the University of Leeds, upon surface combustion appear to have attracted more than a passing interest in engineering circles, and if their application in actual practice bears out the results attained in the laboratory, the subject will undoubtedly have a potent influence upon present boiler practice.

In the Nov. 21 issue, space was devoted to the principles of surface combustion and to a description of Prof. Bone's experimental boiler with which he was able to obtain an evaporation of over 21 lb. of water per square foot of heating surface, at an efficiency of nearly 95 per cent.

Following these extraordinary results, comes the announcement that a boiler of the same type, but of larger size and capable of evaporating at least 5500 lb. of water per hour, has recently been constructed for the Skinningrove Iron Co., of Yorkshire. This boiler, which is shown in Figs. 1 and 2, as erected in the shops of the builders, Richardson & Westgarth, is 10 ft. in diameter, 4 ft. long and contains one hundred and ten 3-in. tubes. It is to be fired with byproduct coke-oven gas which will be drawn through the boiler by a fan capable of producing a suction equivalent to 20 in. of water. The products of combustion, having traversed the boiler tubes, pass to a semicircular chamber at the back of the boiler (see Fig. 2), thence through a duct to the economizer; the fan, which is attached to the economizer, discharges them through a short duct to the atmosphere. No stack is required.

For the benefit of those not having read the previous article upon the subject, it might be well to review briefly the principles of surface combustion and the results attained with Prof. Bone's experimental boiler. Surface combustion is based upon the fact that a mixture of gas and air, in the proper proportions for complete combustion, is caused to burn without flame when in contact with a granular incandescent solid, the combustion taking place only in the layers next to the incandescent surface, providing the mixture is fed at a velocity greater than the propagation of backfire.

The advantages claimed for this system are, (1) the combustion is greatly accelerated by the incandescent surface, and if so desired, may be concentrated just where the heat is required; (2) the combustion is perfect with a minimum excess of air; (3) the attainment of very high temperatures is possible without the aid of elaborate regenerative devices; (4) owing to the large amount of radiant energy developed, transmission of heat from the seat of combustion to the object to be heated is very rapid.

Applying these principles, Prof. Bone designed and built his experimental boiler (see Fig. 3), the main features of which will herein be reiterated. It consists of a cylindrical shell traversed by ten 3-in. tubes, 3 ft. in length. These tubes are packed throughout their length with fragments of refractory material, and into the front end of each tube, where the gaseous mixture is introduced, is fitted a fireclay plug, through which is bored a circular hole of about ¾ in. diameter. This plug serves the double purpose of keeping the front end of the boiler cool and of providing a suitable aperture through which the gaseous mixture may be introduced at a speed very much higher than the speed of back-firing.

Attached to the front plate of the boiler is a mixing chamber of special design, the mixture as fed into the tubes from this chamber containing a proportion of air very slightly in excess of that required for complete combustion. The mixture is injected or drawn in (either by pressure or by suction) through the orifice in this fireclay plug, onto the incandescent material in the tubes. The combustion is completed by the time the mixture has traversed a distance of about 6 in. from the point of entry to the tube, the remainder of the material acting as a baffle for the burnt gases and causing them to impinge repeatedly on the walls of the tubes. The gases leave the boiler at a comparatively low temperature (about 450 deg.) and then pass to a short

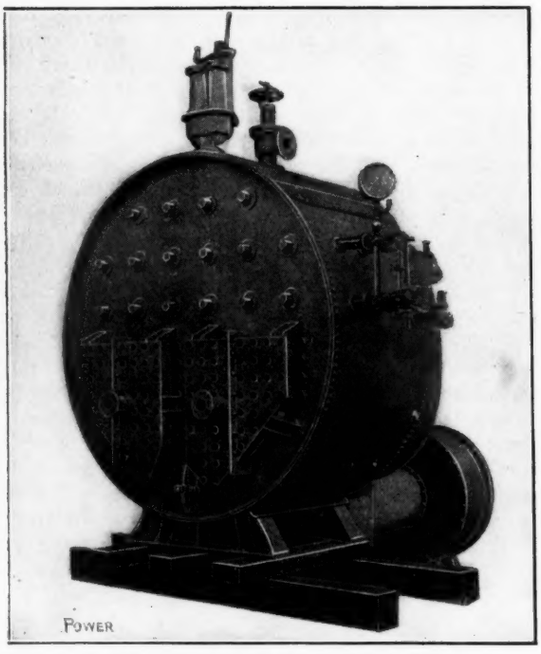


FIG. 1. FRONT VIEW OF BOILER

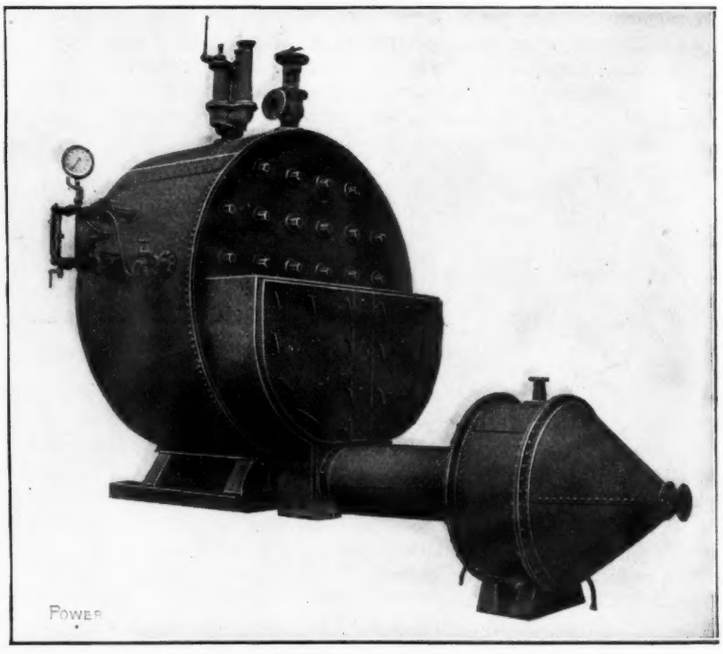


FIG. 2. REAR VIEW OF BOILER AND ECONOMIZER

tubular feed-water heater or economizer at the rear of the boiler, finally emerging at a temperature of about 200 deg. F. with the feed water at 130 deg.

When starting up, air alone is admitted to the chamber *C* by means of the tubes *A* and gas alone to the chamber *D*, by means of the tubes *B*. The small tubes *F* convey the gas to the centers of the fireclay bushes in the several tubes and it is ignited as it issues from the left-hand or free ends of the boiler tubes, and the gas and air supply adjusted until the flame strikes back and combustion proceeds in the bed of fireclay. When the mass has become incandescent the gas supply to chamber *D* is shut off and through the pipes *A* a combustible mixture of gas and air is admitted. The separate admission is necessary at first to prevent the backfiring of an explosive mixture during the starting-up process.

Tests of this boiler using a mixture of Leeds coal gas and air introduced at a pressure of 17.3 in. of water, showed an evaporation of 21.6 lb. of water per square foot of heating surface into steam at 100 lb. and a combined boiler and economizer efficiency of 94.9 per cent. This exceptionally high efficiency may be accounted for by the very small excess of air, the complete combustion and the small radiation losses. The gases left the economizer at 203 deg. F. and the feed water entered boiler at 136 deg.

From a structural point of view, this boiler possesses certain advantages: No chimney is necessary, and being supported upon a casting, no elaborate setting is necessary. Furthermore, the front head can never be heated beyond the temperature of the water, which, with the short length of tubes, implies an absence of strain and greatly reduces the liability of leaky joints. Of course, its short length necessitates a greater diameter, but this is largely compensated for by the high rate of evaporation. With a mean evaporation of over 20 lb. per square foot of heating surface, it is estimated that about 70 per cent. occurs over the first third of the tube length, 22 per cent. over the next third and 8 per cent. over the remaining third. Such a steep gradient should cause a rapid circulation of the water within the boiler.

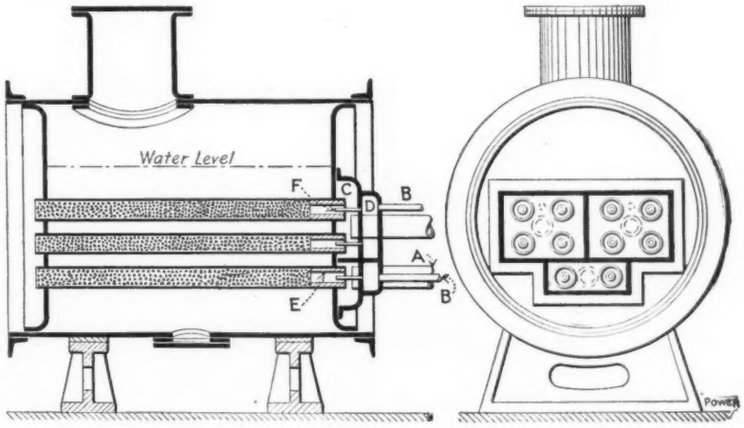


FIG. 3. EXPERIMENTAL BOILER

Electrical Reduction for Ship Propulsion

Before the united engineering societies of Boston, W. L. R. Emmet, of the General Electric Co., spoke upon the above subject with which his name has become identified by the contribution of numerous papers and discussions. His talk was informal and was based upon his former utterances. Mr. Emmet certainly makes out a strong case for electrical transmission between the turbine and the propeller.

It is often asked why motors should be used when in certain cases mechanical gearing has been successfully applied to speed reduction for this purpose, and it is not easy to give a definite answer to this question, since the limits of the application of gears are as yet very imperfectly understood. In this connection, said Mr. Emmet, it must be borne in mind that the performance of large high-speed gears must be considered as problematical, while the facts of electric speed reduction are established and certain.

The only ship that is being successfully propelled by gears is the S.S. "Vespasian," equipped by Sir Charles Parsons two or three years ago. This vessel operates with a single screw, to which 1000 hp. is delivered by two turbines. Each of these turbines drives a pair of helical pinions, the diameter of these pinions being 6 in. The diameter of the large gear, which is mounted upon the propeller shaft, is 10 ft., the speed reduction being 20 to 1. The face of each half of the pair of pinions Mr. Emmet did not know exactly, but his recollection was that it is about a foot, giving 2 ft. of working pinion length for each turbine shaft. The propeller operates at about 80 r.p.m. and the turbine at about 1600 revolutions per minute.

The speaker made a comparison between this case and the case of a large electrically propelled ship where the total horsepower is 17,000, delivered to twin shafts. The propeller speed is 84 r.p.m. and the turbine speed is 1800 r.p.m.

If each of these shafts were driven through gearing by two turbines, as in the case of the "Vespasian" shaft, each of the four turbines so used would have to deliver 4250 hp., and it is obvious that it would not be possible to deliver so large an amount of power to a pinoin having a diameter of only 6 in. If this were so, it would be necessary to greatly increase the length of the pinion in order that the pressure between teeth may be kept down. If the length of the pinion is increased, the strain imposed upon it will cause it to exert all its force at the driven end, the torsional elasticity of the pinion being such as to entirely relieve the opposite end from pressure. Thus to make a long pinion operate throughout its length, sufficient diameter must be had to give the necessary torsional stiffness, and theoretically it is impossible to conceive of a pinion which will not tend to bear harder at the driven end than it does at the opposite end.

If to avoid these difficulties the diameter of the pinion is increased, its peripheral velocity must also be in-

SHIPS FOR WHICH ELECTRIC PROPELLING MACHINERY HAS BEEN DESIGNED

Vessel	Displacement	Shaft Horsepower	Approximate Weight, Main Engines or Turbines, Tons	Weight, Corresponding Electric Drive, Tons	Speed, Knots	R.p.m., Electric Drive	Water Rate, Electric Drive without Auxiliary, Pounds per Steam Horsepower	Steam Conditions
"Cyclops"	19,360	6,850	335	135	14	110	12.0	200 lb. gage, 28.5" vac. dry
"P.S. 445"	25,000	12,500	411	237	16	110	11.5	200 lb. gage, 28.5" vac. dry
"Delaware"	20,000	3,400	435	374	12	87	12.85	260 lb. gage, 28.5" vac., 50 deg. superheat
		17,300	435	374	20	148	11.5	260 lb. gage, 28.0" vac., 50 deg. superheat
"Everett"	10,945	2,275	102	55	10.5	85	13.0	175 lb. gage, 28.0" vac., dry
"Otaki"	9,900	5,500	....	133	14.6	114	12.5	181 lb. gage, 28.0" vac. dry
Unnamed	.....	17,000	910	430	17.5	84	11.0	190 lb. gage 28.5" vac. dry

creased or it will be necessary to diminish the speed of the turbine which drives it or increase the diameter of the large wheel, and any of these changes may involve serious difficulties. As the parts of such a structure are made larger, the difficulty of maintaining perfect accuracy of engagement between them increases, and the weights and spaces occupied are rapidly multiplied.

Some engineers who are advocating the use of gearing for ship propulsion have proposed the use of peripheral velocities in some cases double that used upon the "Vespasian," but even with these extreme assumptions the gearing for such a ship would be a very formidable affair, and it would be necessary either to diminish the turbine speed or increase the propeller speed to keep its proportions within reason. Even if the gearing itself involved no loss, it is probable that the necessary disadvantages in the turbine and propeller would more than offset the electrical losses which must be incurred if Mr. Emmet's method is adopted. The total electrical loss in such a ship as the "Vespasian" amounts to only 8 per cent. and this loss constitutes the only valid argument which can be brought against electric propulsion as compared with propulsion by gearing. With an electric propeller it is known that both the turbine and the propeller can be operated at the most advantageous speeds, and that all the advantages incident to doing so can be gained; with mechanical gearing, there is no such knowledge, and the facts actually demonstrated fall very far short of such an ideal.

The accompanying table gives approximate figures concerning the number of ships of different types for which electric propelling machinery has been designed.

The Passing of One of Corliss' First Engines

In his paper, "The Power System of the Pacific Mills," presented at a recent meeting of the Boston Society of Civil Engineers, the Mechanical and Electrical Engineers coöperating, Fred A. Wallace, to whom we are indebted for the drawings reproduced herewith, drawn by him largely from memory, made a forcible comparison between the prime mover of today and that of the middle of the past century, emphasizing it by a description of one of the original engines of the Pacific Mills, which was torn down in the reorganization for the new central power plant.

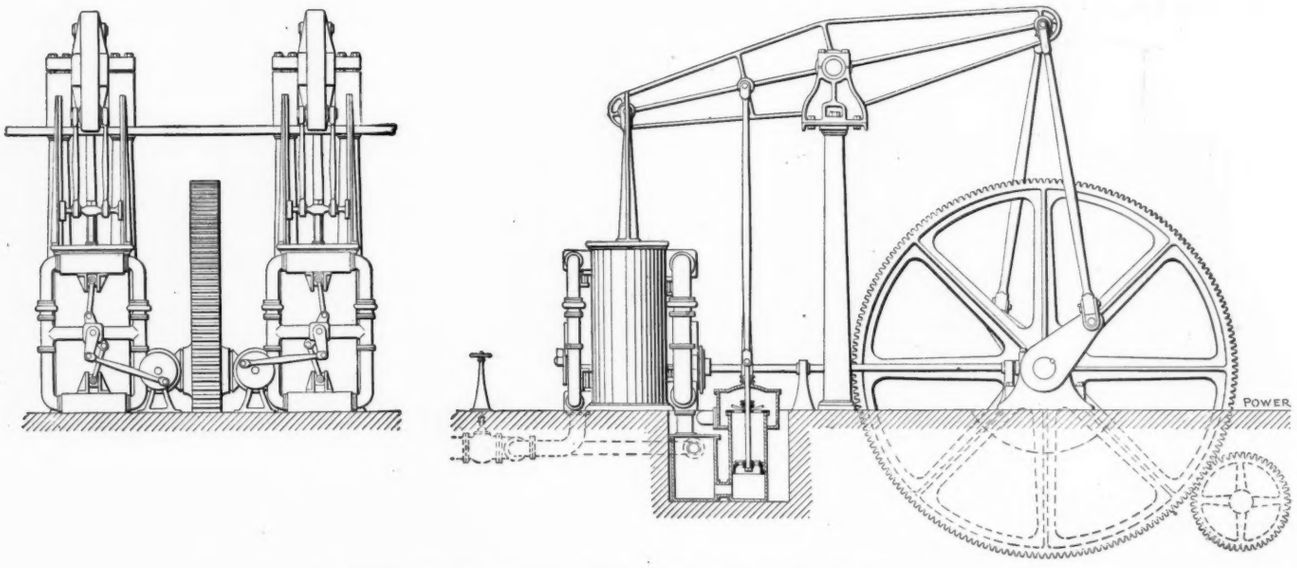
The double walking-beam engine which was removed by these changes was, for sentimental reasons, torn down with regret, said Mr. Wallace. As this was an engine designed over 60 years ago, a description may be interesting. It was of the double walking-beam type, having two vertical cylinders 38x40 inches, both operating condensing. The flywheel has a gear 20 feet in diameter and 18 inches face, having a pinion on the waterwheel jack shaft. The engine in its general appearance was like the famous Centennial engine but not so elaborately finished. It was built by Nightingale, Bancroft & Co., of Providence, R. I., in 1847, and was one of the first engines in which George H. Corliss was interested. It was made before the rotary cutoff valve was invented and the valves were plain slides, one inlet and one exhaust on each end of the cylinder. They were operated from a gear on a lay shaft. The engine was built to operate with 30 pounds steam pressure and to run at 30 revolutions per minute; the speed was controlled by a throttling governor. Although designed for 450 horsepower, it has developed 900 horsepower. The condenser was of the jet type, of the simplest form, as shown in the sketch. The pump was a common bucket arrangement 24 inches in diameter by about 36 in. stroke, with two large brass valves hinged in the center and each covering nearly one-half of the area of the piston. One single rubber valve 24 inches in diameter by ⅞ inch thick constituted the upper deck.

In 1897 this engine was overhauled and the valves were adjusted to run on low-pressure steam which was taken from an exhaust system into which nearly 100 engines and pumps of various sizes exhausted. Enough of this exhaust steam was used by the engine to produce about 350 horsepower and the remainder was used for manufacturing purposes.

The engine is thus further interesting in that it is one of the first large power units to run on exhaust steam. No tests were made to determine the efficiency, but it must have been very good under the conditions in which it was run. In the changing of this engine to low pressure and adjusting to increase its efficiency with a higher vacuum, the fact was realized that there is as much energy in a pound of steam expanding from atmospheric pressure to 27 inches of vacuum as when expanding from 120 pounds to the pressure of the atmosphere.

The engine was offered to several educational and other institutions in the hope that it might be preserved as an example of engineering before the advent of the Corliss type of engine, but its great bulk made it impossible to find a suitable home for it and it was reluctantly broken up.

It occupied practically three floors of a building 50x30 feet and developed nominally only 450 horsepower.



DOUBLE WALKING-BEAM ENGINE DESIGNED OVER 60 YEARS AGO

Electrical Department

Conducted to be of service to the men in charge of electrical equipment in the power house

Locating Defects in Direct Current Armatures

BY GORDON FOX

The faults which most commonly develop in direct-current armatures are short-circuits, open circuits and grounds. The location of a short-circuit or an open circuit in an armature in service is usually self-evident. In case of a short-circuit in any coil or between commutator bars, excessive heat is developed in the affected coil, often causing smoke to be given off. By revolving the armature slowly by hand while still hot and feeling carefully of the armature-coil ends and commutator segments, it is quite easy to determine the hottest points and mark the coil in trouble.

In case of an open circuit in an armature in service, bluish green rings of fire will encircle the commutator. The mica strips adjacent to the bars to which the open coil is connected will be very noticeably pitted by the arcing across them. In a four-pole machine there will be two pitted strips located diametrically opposite each other. In a six-pole machine there will be three pitted strips 120 degrees apart.

The location of a ground can sometimes be detected by the odor of burnt insulation at the defective point. If the ground is only partial, a high potential impressed between the winding and the ground may cause an arc, which will betray the location of the trouble.

A simple device which may be used to locate accurately all "shorts," opens, grounds or cross-connections in any direct-current armature is illustrated in Fig. 1. The method of using it consists in inducing a small alternating electromotive force in the armature coils and then testing by means of a telephone receiver from bar to bar for defects. To induce the electromotive force in the armature coils, the U-shaped magnet, which has a laminated iron core, is excited with alternating current and the poles are applied to the armature core so that they are opposite the two sides of a coil. In order to make the magnet adaptable to different sizes of armature, the pole pitch may be made adjustable by hinging at the center, shortening half of the laminations, interleaving the others and fastening with a bolt passed through axially.

The cross-section of the magnet core should be about 2x8 in., the longer dimension being that parallel to the armature slots. For 110-volt alternating-current supply each coil should consist of about 60 turns of No. 6 double-cotton-covered wire wound over mica insulation on the core. Pins may be set into the core to hold the coils in place, as shown in Fig. 1.

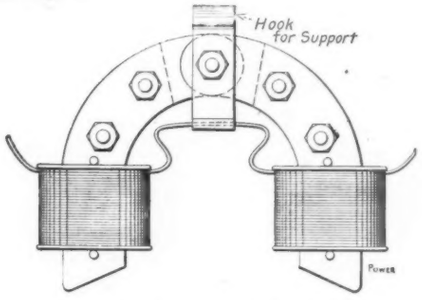


FIG. 1. INDUCING MAGNET

The magnet may be suspended from a small rope fall and lowered over the armature, which should be so supported on horses or in a lathe that it may be rotated. There should be about ¼ in. clearance between the pole tips and the armature core. Fig. 2 shows how the device should be applied. With the magnet thus located and its winding excited with alternating current, there is induced in the armature coils an alternating electromotive force; and a slight potential difference therefore exists under normal conditions between adjacent commutator segments. If a telephone receiver be connected from one bar to the next adjacent bar, a small alternating current will flow through it, setting the diaphragm into vibration, and a humming sound will result.

In case a short-circuit exists between the bars being tested, there will be no voltage difference between them and the receiver will indicate the short-circuit by failure to vibrate. In case of a short-circuit between two turns of a multi-turn coil, the humming of the receiver will be decreased considerably, depending on the number of turns short-circuited. A cross-connection is indicated when groups of three or four bars symmetrically spaced test silent. A few top coil sides must be lifted out of the slots and tested out to determine the exact location.

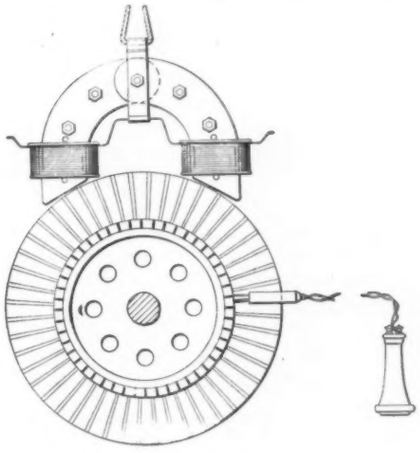
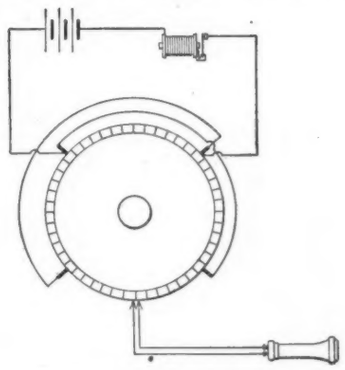
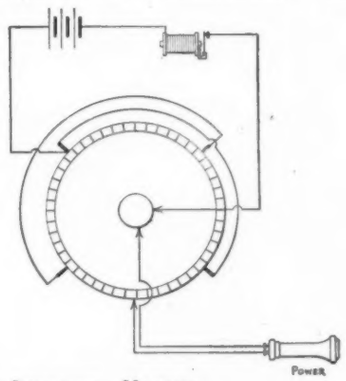


FIG. 2. APPLICATION OF MAGNET AND EXPLORER

When an open circuit exists, a comparatively large potential difference results between the bars connected to the defective coil. Consequently, the receiver responds with a loud click when such a point is reached. A dead ground is merely a short-circuit between some coil and the core. It can therefore be located by the short-circuit method, connecting one receiver terminal to the shaft and testing each segment with the other. If the armature is grounded, the receiver





FIGS. 3 AND 4. SUBSTITUTE FOR INDUCING MAGNET

will test silent on the bars connected to the grounded coil. On the other bars a sound will result and its intensity will decrease as the grounded bar is approached. This test can only be used when a dead ground exists.

In using this method of testing for faults, care should be taken to keep the position of the magnet at all times the same with respect to the armature core and the telephone terminals; otherwise, the effects of varying field strength may lead to erroneous conclusions. A pair of exploring terminals* should be used and kept in one position, the armature being slowly rotated to change the segments under test.

Although this is an excellent method for use in a repair shop, it is not always practicable, due to the requirement of a special exciting magnet. A modification of this method, however, can be easily applied to any direct-current armature without removing it from its bearings. A storage battery or a few dry cells and a buzzer may be used to replace the inducing magnet. The battery and buzzer are connected in series and the terminals placed under brushes of opposite polarity, as represented in Fig. 3. The exploring terminals attached to the receiver are then placed on the commutator about midway between brushes and the armature slowly revolved, so as to test from bar to bar as previously described. The interrupted current acts similarly to the alternating current induced by the exciting magnet and the results are the same. It is difficult, however, to locate a short-circuit between turns by this method.

*See Fig. 6 and accompanying description on page 892, Dec. 12 issue of Power.

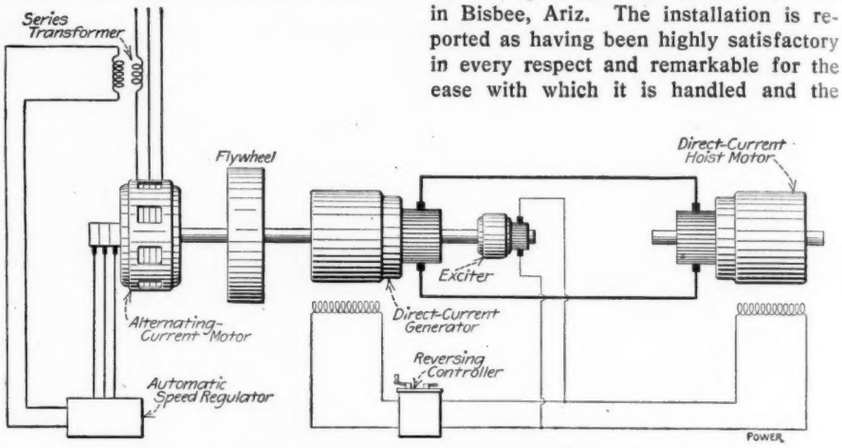


FIG. 1. DIAGRAM OF LOAD-EQUALIZING HOIST SYSTEM

To locate a ground, one battery terminal should be connected to the motor frame and the other terminal left under one brush as before. The receiver terminals are connected to ground and to successive segments, as shown in Fig. 4. The receiver will test silent when the grounded bar is reached.

The Westinghouse Load-Equalizing Hoisting Set

The Calumet & Arizona Mining Co. recently completed an elaborate set of tests on an electric hoisting system which has been in operation some time at its mine in Bisbee, Ariz. The installation is reported as having been highly satisfactory in every respect and remarkable for the ease with which it is handled and the complete control which the operator has over it.

Tests have shown that even under severe operating conditions where the hoist is running a great portion of the time, the average intake of the system over a day's run will not be more than about 25 per cent. of the maximum load,

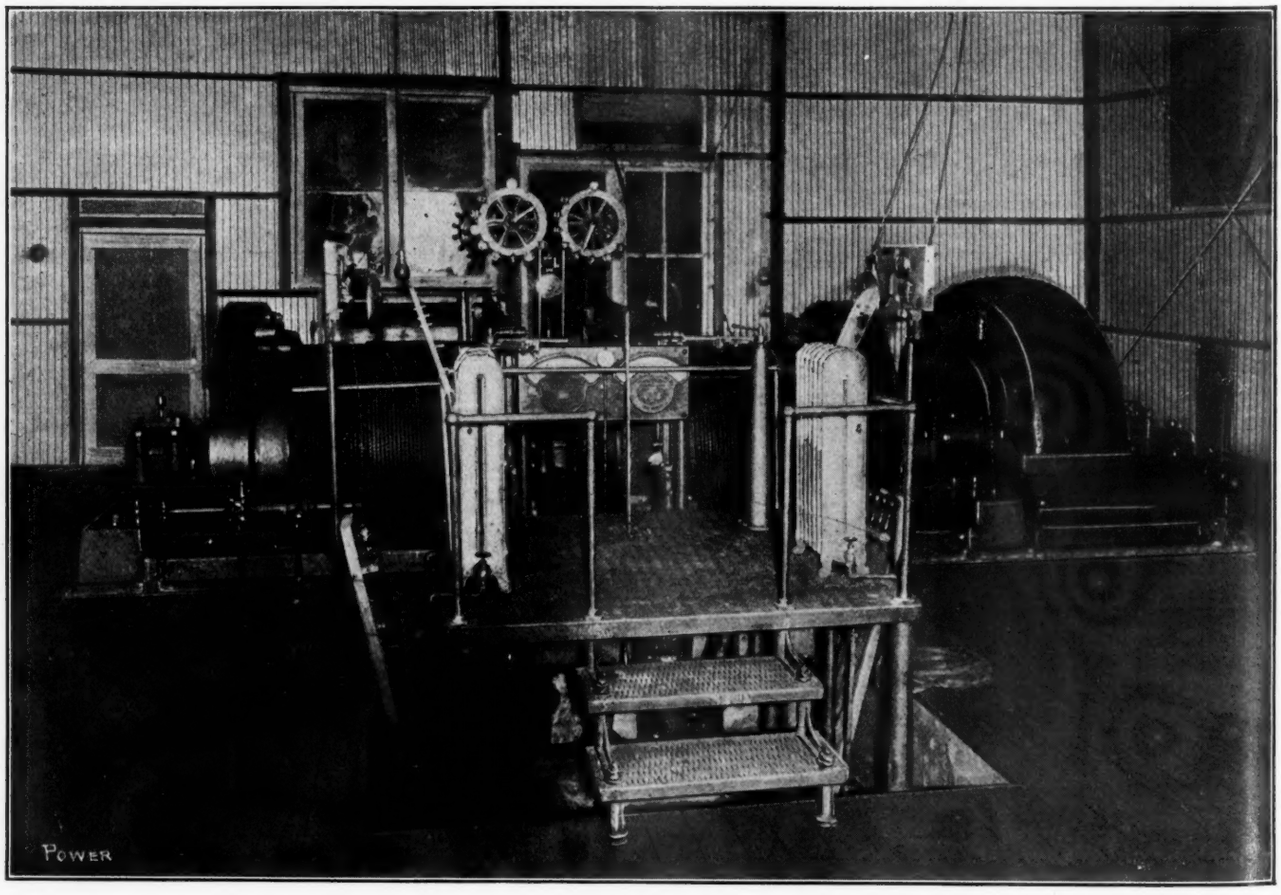


FIG. 2. THE HOISTING EQUIPMENT AND CONTROL APPARATUS

and that the rate of intake is practically constant.

With small hoists, it has been found satisfactory to use alternating-current induction motors directly applied, but where heavy loads are to be handled and at high speed, the peak due to the acceleration of the rapidly moving parts is always greatly in excess of the average requirements of the hoist. If the current is supplied from a line also carrying a lighting load, the resulting fluctuations of voltage prove most objectionable.

Furthermore, in most cases the hoist is at the end of a long transmission line and an excessive amount of copper must be installed to prevent a serious drop in the voltage during the maximum demand; in other words, the line must be equipped for the peak load instead of the average load, at a greatly increased expense.

It was to overcome these undesirable conditions that the Westinghouse load-equalizing hoisting plant was devised. The essential features of this system are diagrammatically shown in Fig. 1. The machinery consists of a direct-current motor direct-connected to the hoist drum, a direct-current generator and its exciter, coupled to an alternating-current induction motor, and a laminated flywheel mounted on the motor-generator shaft. The equipment also includes a reversing controller for the generator field winding, a speed regulator for the induction motor, a series transformer and a switchboard.

The hoist proper was built by the Denver Engineering Works, and it has a normal duty of 6000 lb. unbalanced load. Its hoisting speed is 1000 ft. per minute.

The brushes of the generator and the hoist motor are electrically connected, directly. The field winding of each machine is excited separately, constant full field being maintained in the motor. The hoist is started by gradually increasing the field strength of the generator and thereby delivering an increasing voltage to the hoist motor. When the load on the alternating-current motor reaches a certain point, resistance is automatically inserted in its secondary circuit, reducing the speed of the set, and the energy stored in the flywheel is used to overcome the peak of the hoisting cycle, economizing in the draft of current from the supply circuit.

The hoist is stopped by gradually weakening the generator field and thus allowing all excess energy in the descending cage, the rotating hoist motor and the drums to be returned to the flywheel through the generator, which momentarily acts as a motor, receiving energy from the hoist motor, which for the moment acts as a generator.

The overall efficiencies of hoists of this type are generally from 50 to 60 per cent. when operated under normal operating conditions.

Because of the ease of control and the general characteristics of the set, it is a simple matter to devise reliable safety devices which do not depend on mechanical brakes. Such devices have been put in practice in Germany, where the government allows men to be hoisted at a speed of 2500 ft. per minute in this type of hoist, whereas with steam hoists provided with the best available safety devices the maximum speed allowed is but 1200 ft. per minute.

The first cost of installation is, of course, somewhat greater than a small motor hoist with rheostat control, but the reduction of power cost due to the equalization of the load is said to be so great that the initial expenditure becomes a secondary matter, especially when power is purchased on any maximum-demand system.

Fig. 2 shows the hoist motor, the drums and the operator's platform at the Calumet & Arizona Co.'s Bisbee plant. The set consists of a Westinghouse 220-hp. shunt-wound interpole hoist motor, direct-connected to the hoist drum; a flywheel motor-generator which comprises a Westinghouse 180-kw. shunt-wound interpole direct-current generator, a 22,700-lb. laminated flywheel and a 180-hp. three-phase induction motor; a Westinghouse 15-kw. 125-volt exciter and, of course, the necessary controlling and regulating devices. The hoist motor runs at 63 r.p.m., maximum, when receiving current at 550 volts from the generator; the induction motor is a 60-cycle 220-volt machine and drives the generator normally at from 1050 to nearly 1200 r.p.m., the latter being synchronous speed.

LETTERS

An Easy Problem in Star Connections

Some time ago trouble with a polyphase wattmeter gave rise to considerable discussion which I should like to submit to the readers of POWER. Our system is a four-wire three-phase one and all of the switchboard instruments are supplied with current through current and potential transformers. Fig. 1 shows the connections of the potential transformers and the potential coils of the wattmeter, as shown in the wiring diagram sent with the switchboard panel on which the meter is mounted. Fig. 2 is the same as Fig. 1 with one transformer left out, while Fig. 3 shows the connections as given in the meter instruction book.

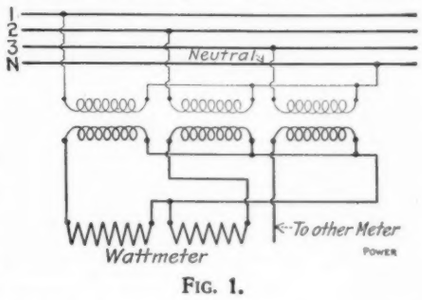


FIG. 1.

I maintain that for all practical purposes the three diagrams are the same, but others say they are not; they contend that in Fig. 1 the transformers are Y-connected and in Fig. 3 they are connected open delta. My opinion is that Fig. 3 is really an open Y-connection and that so far as the wattmeter is concerned will give the same results as Fig. 1. Who is right?

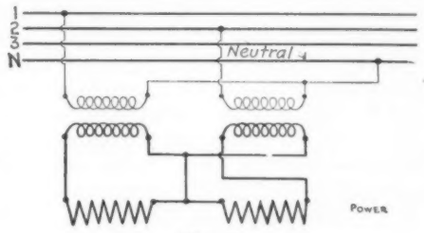


FIG. 2.

W. RUSSELL COOPER.
Indianapolis, Ind.

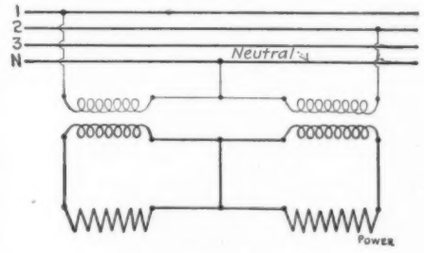


FIG. 3

[Fig. 3 is not the exact equivalent of Fig. 2; neither is it an open delta connection. No true delta connection is possible with transformer terminals connected to a neutral. The relations between Figs. 1, 2 and 3 are not difficult to analyze and we shall leave their analysis to the readers.—EDITOR.]

Rotary Converters vs. Motor Generators

I note in the Electrical Department of the Dec. 5 number a table by Mr. Tupper on page 854 purporting to give the best general practice as regards the use of motor-generators or rotary converters for various frequencies and direct-current voltages. In particular, he refers to the use of a motor-generator as preferable on a 60-cycle circuit with a direct-current voltage of 600. In the article he states that there is considerable trouble in the operation of converters at 60 cycles, flashing over and hunting being the chief troubles.

I do not know how far back Mr. Tupper has gone for his data. Not many years ago one company manufacturing machines of this character had a great deal of trouble with its rotary converters flashing over, also hunting, at about 600 volts on 60-cycle work. One of the other companies, however, manufactured

this class of apparatus which gave absolutely no trouble with voltages as high as 650 and over on a tremendously varying railway load; and at the present time I believe many of the electrical companies can build converters for these conditions which will give service that will compare favorably with 25-cycle operation. The chief difficulty with converters of this character is to get a low difference of potential between commutator bars without having the commutator surface run at an excessive velocity.

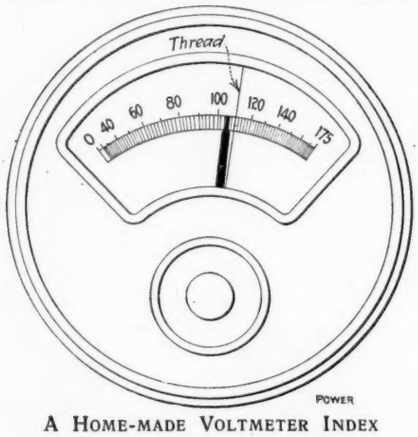
With the old-type converter, in which the field was comparatively weak and the neutral point was constantly shifting owing to the variable load, a great deal of trouble was experienced; also, when the converter was not provided with pole-face grids or some other device to prevent the hunting. The modern converter, either with a strong, stable field and grids or with interpoles, will give satisfactory operation on 60-cycle circuits and direct-current voltages of 600 and considerably over. The only condition under which a motor-generator is more satisfactory than a rotary converter is that where a wide variation of direct-current voltage is essential. Rotary converters can be compounded and operated with perfect satisfaction where the voltage is to remain within moderate limits, and they have the advantage of being far less costly and much simpler.

HENRY D. JACKSON.

Boston, Mass.

A Simple Way to Put an Index on a Voltmeter

A voltmeter that is not provided with an adjustable index to show where the needle ought to point causes inconvenience, if the voltage is likely to vary often, because one cannot tell from a distance whether the needle is at the right point on the scale. To correct this defect I put an index on my voltmeter. I made a mark on the outside of the glass, with something that rubs off easily, at the point where I wish to keep the voltage. Then I took the glass out and glued a piece of thick black thread on the inside to agree with the mark on the outside and rubbed off the outside mark.



A HOME-MADE VOLTMETER INDEX

This has the advantage that cleaning the glass does not disturb the index, as it would if the thread were glued to the outside face of the glass. The accompanying sketch shows the index in place. This may not be new, but I have never seen it before and I have found it to be a great help in watching the voltmeter.

SAMUEL H. WINTERBOTTOM.

Woonsocket, R. I.

That Line Current Problem

In the Inquiries Department of the Nov. 28 issue, I noted with interest the answer to a request by "G. A. H." for a method of calculating the line current when the delivered voltage is not known. The formula given is correct, but the one given below is somewhat simpler and has the advantage of following the general equation:

$$Amperes = \frac{Watts}{Volts}$$

My formula is:

$$Amp. = \frac{Watts}{\sqrt{\left(\frac{Volts}{2}\right)^2 - watts \times res. + \frac{volts}{2}}}$$

MURRAY RANEY.

Springfield, Ill.

The formula given in the Inquiries Department in reply to "G. A. H.'s" question is, of course, correct, but it is not the easiest method of finding the desired current strength. The relation between the generator voltage, line resistance, delivered power and line current is:

$Watts = Volts \times Amp. - Res. \times Amp.^2$

and an easy way to find the value of the line current is to assume a low current value, a medium value and a high one and plot a small chart showing the relation between watts and amperes.

The accompanying chart illustrates what I mean. It is plotted from the figures given in the example which was stated in the answer to "G. A. H." The currents assumed were 20 amperes, 60 amperes and 100 amperes. At 20 amperes the delivered watts would be:

$$500 \times 20 - \tfrac{1}{2} \times 20^2 =$$
$$10{,}000 - 200 = 9800$$

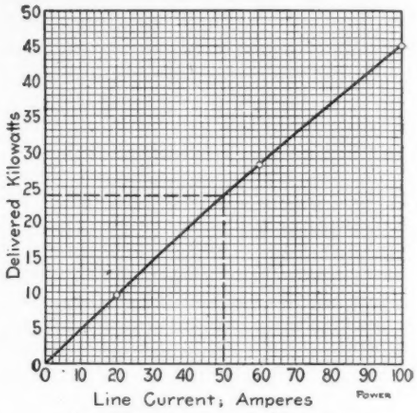
watts, or 9.8 kw. At 60 amperes, the delivered power would be

$$500 \times 60 - \tfrac{1}{2} \times 60^2 =$$
$$30{,}000 - 1800 = 28{,}200$$

watts, or 28.2 kw. At 100 amperes, the delivered watts would be 45 kilowatts.

Using a piece of ordinary cross-section paper, lay off a scale of amperes on the bottom and a scale of kilowatts up the side and locate one point at the intersection of the 20-ampere line and the 9.8-kw. line, another at the crossing of the 60-ampere and 28.2-kw. line, and the third at the crossing of the 100-ampere and 45-kw. lines. Then draw a curve through the three points and the zero point, as shown.

By tracing from any value of kilowatts over to the diagonal curve and thence



MR. WING'S CHART METHOD

down to the bottom scale, the corresponding current may be found.

This method is almost as short as solving the equation given, and the liability to error is much smaller.

STEPHEN R. WING.

Ithaca, N. Y.

Mr. Raney's formula is correct and is also less tedious to work with than ours, which was the conventional solution of the affected quadratic

$Volts \times Amp. - Res. \times Amp.^2 = Watts$

Mr. Wing's method is much quicker than the calculation, but it would be rather difficult to obtain accuracy with it if either the current or the delivered power should happen to be expressed in several figures and the values should not be easily located on a scale of relatively few divisions. For example, if the delivered power were 28,457 watts and the corresponding current 257 amperes it would be necessary to plot a very large chart to determine the values correctly. The method is excellent for approximations and for small values of current and delivered power.—EDITOR.

An important water-power development is now nearing completion on the Ocoll River, at Parkville, Tenn. A maximum head of 114 ft. has been made available by the construction of a concrete dam impounding the water so as to form a lake 2000 acres in extent. It is estimated that the development will yield about 32,000 hp., the power being transmitted at 66,000 volts to Cleveland, Chattanooga, Knoxville and other surrounding cities.

According to the United States Geological Survey, the coal output in this country for the year 1910 exceeded that of Great Britain by over 200,000,000 tons.

Heating and Ventilation

Considered as power-plant problems. Layout and operation of systems and apparatus

Coal Required to Heat Modern City Building

By E. F. Tweedy

The artificial heating of all habitable buildings throughout the greater part of the temperate zone is necessary during some six to eight months of the year, if inside temperatures conducive to the physical comfort of those who reside within are to be maintained.

Some idea of the relative importance of this heating problem in different sections of our own country may be obtained by referring to Fig. 1, which shows the mean monthly temperatures in a number of cities located in various parts of the United States.

This chart is based upon the assumption that artificial heating is required when the mean outside temperature is below 55 degrees Fahrenheit, and that the amount so required is proportional to the difference between 70 degrees Fahrenheit (the assumed inside temperature) and the mean outside temperature. The mean temperature for a given month is plotted upon a vertical line erected at the middle point of the corresponding month. Straight lines are drawn between the various points thus obtained, and from the two points where the horizontal line through 55 degrees Fahrenheit is crossed, vertical lines are erected to meet a horizontal line drawn through 70 degrees Fahrenheit. The areas of the polygons thus obtained roughly represent the heating requirements in the several cities which have been selected for comparison. The intercepts upon the horizontal line drawn through 55 degrees Fahrenheit give an approximate idea of the number of days comprising the heating season, for each city. Table 1 gives the mean monthly temperatures of these several cities, as well as the mean temperatures during the heating season and the number of days during which heating is required, both of the latter sets of figures being obtained from Fig. 1. The last line of this table gives the heating requirements of each of these cities as a percentage of those of New York City. In determining these relations, however, no allowance has been made for any differences in mean wind velocity, although this is a factor which may materially affect the heating requirements, as is shown later on. Furthermore, they make no allowance for those days, if any, during the heating season when either no, or only a small amount of, heating may be required, such as on Sundays, holidays, etc., and they therefore do not afford an accurate means of comparing the heating requirements of two given buildings located in different cities, if the operating conditions of these buildings, as regards continuity of heating, are radically different.

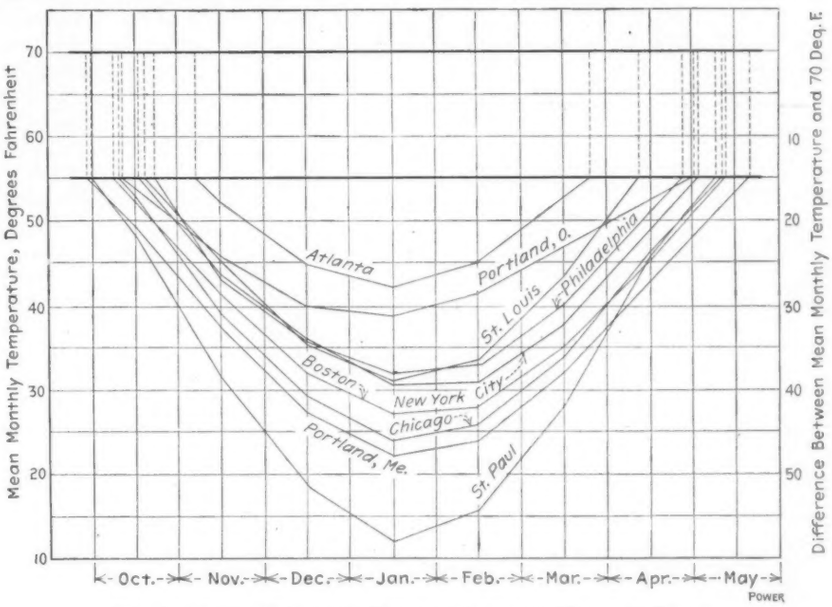


FIG. 1. MEAN MONTHLY TEMPERATURES IN VARIOUS CITIES

The loss of heat by transmission through the various materials of which modern buildings are composed, has been made the subject of much experimental study, and, as a result of the many investigations which have been made along these lines, it is now possible to predict, with a considerable degree of accuracy, the loss of heat which any given building will experience by transmission through its walls, roof, etc., for any given conditions as regards building exposures and outside and inside temperatures, when the nature of the materials of which the building is constructed, together with the thicknesses of such materials, is definitely known.

Table 2, compiled from data given by various authorities, shows the approximate amount of heat that is transmitted per square foot per hour for every degree difference in temperature between the inside and outside air for a few of the materials most commonly used in the construction of modern city build-

TABLE 1. MEAN MONTHLY TEMPERATURES

	Portland, Ore.	St. Louis, Mo.	St. Paul, Minn.	Atlanta, Ga.	Philadelphia, Pa.	Boston, Mass.	Portland, Me.	Chicago, Ill.	New York, N. Y.
January	38.7	31.0	11.9	42.2	31.8	27.0	22.0	24.0	30.6
February	41.4	33.5	15.4	45.2	32.8	28.0	23.8	25.7	30.7
March	46.1	43.5	28.2	52.4	40.0	35.0	32.0	34.9	37.8
April	51.8	56.1	45.8	61.1	50.8	45.3	43.0	46.2	48.7
May	57.7	66.5	57.7	69.5	62.2	56.6	53.5	56.6	59.8
June	62.5	75.1	67.2	75.6	71.2	65.8	62.6	66.5	69.0
July	67.3	79.1	72.0	77.6	75.8	71.3	68.0	72.3	74.1
August	66.6	77.2	69.7	76.1	73.8	68.9	66.2	71.3	72.6
September	61.3	70.0	60.5	72.1	67.4	62.7	59.6	64.8	66.5
October	53.7	58.4	48.4	62.4	56.3	52.3	49.1	53.1	55.6
November	45.7	43.4	31.0	51.9	44.9	41.2	37.6	39.4	43.9
December	40.2	35.5	18.8	44.6	35.7	31.6	27.1	29.1	36.0
Mean for year	52.8	55.8	43.9	60.9	53.6	48.8	45.4	48.7	52.1
Mean during heating season	49.9	43.1	35.4	51.4	44.4	42.3	41.1	41.5	43.0
Difference between 70° and mean during heating months	25.7	28.5	39.0	22.0	28.3	30.4	32.3	32.0	28.8
Number of days during heating season	203	178	223	139	190	216	234	212	197
Per cent. of New York City heating requirements	92	90	154	54	95	116	133	119	100

ings. The heat losses as given in this table are, when used as a basis for calculating the amount of radiating surface required, generally increased by some 10 to 20 per cent. when the exposure is a northerly one; by 10 to 30 per cent. when the building is heated during the daytime only, the percentage of increase depending upon whether the building is in a protected or in an exposed location, and by 50 per cent. when the building is heated only intermittently, with intervals of considerable duration when the building is without heat.

TABLE 2

BRICK WALLS

Thickness, in.	8	12	16	20	24	30	36
B.t.u. loss per sq.ft. per hr. per degree diff. in temp.	0.46	0.32	0.26	0.23	0.20	0.17	0.13

STONE WALLS (Sandstone)

Thickness, in.	12	16	20	24	28	36	44
B.t.u. loss per sq.ft. per hour per degree diff. in temp.	0.44	0.38	0.36	0.30	0.27	0.24	0.20

B.t.u. loss per square feet per hour per degree difference in temperature.

Single window	1.03–1.1
Double window	0.45–0.52
Single skylight	1.00–1.14
Double skylight	0.42

changes per hour for that portion of the building which is to be heated, but this method is uncertain at best and it may lead to considerable error.

In order to eliminate the uncertainty that arises from estimating the heat loss due to air leakage by assuming an arbitrary number of air changes per hour, the writer employs a method which combines this loss with the heat loss due to transmission, both being expressed in terms of equivalent glass. The possibility of making such a combination was arrived at by the following line of reasoning. The loss due to air leakage is proportional to the summation of the window perimeters (assuming the leakage space around the windows to be approximately constant in width), but as the dimensions of the windows in similar types of city buildings are fairly uniform, it becomes possible to consider the leakage loss as a function of the total window-glass surface, when deriving a general expression for the loss of heat from buildings of a given type, without introducing any considerable amount of error.

In reducing wall exposure to equivalent glass, a ratio of 4.5 to 1 has been taken as representing the relation which

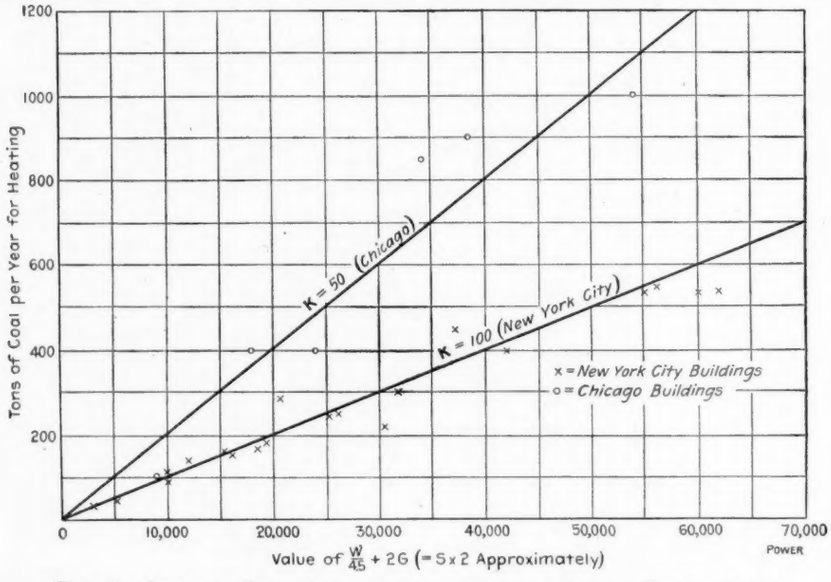


FIG. 2. ANNUAL COAL CONSUMPTION PLOTTED AGAINST TOTAL GLASS EQUIVALENT

The loss of heat occasioned by the leakage of air at the windows and doors is, however, not subject to precise calculation, and this loss may result in an insufficient amount of radiating surface being provided, unless proper allowance is made to cover this loss, either by basing the estimate upon previous experience or by following one of the more or less empirical methods that are frequently used in providing for the loss of heat due to this cause. The most common method of making provision for this loss is to assume an arbitrary number of air

the heat-transmitting properties of glass bear to those of the materials of which the walls of the average building in New York City are constructed. Having made the foregoing assumptions, the following equation results:

$$T = \frac{\frac{W}{4.5} + G}{\frac{K}{K'}} + \frac{G}{K'}$$

where

T = Tons of coal consumed per year for heating;

W = Total exposed wall surface in square feet;

G = Total window-glass surface in square feet;

K and K' = Constants for buildings of the same type and of similar form of construction.

As it is not necessary to solve the above equation, K and K' need not be separately determined. However, in order to provide a relation between the actual coal consumptions and the total glass equivalents of the buildings that were investigated, it was necessary to express K' in terms of K. For $K' = K$, the equation evidently becomes

$$T = \frac{\frac{W}{4.5} + 2G}{K}$$

The relation between K and K' can be varied considerably without affecting the result to any appreciable extent other than to alter the value of K.

Fig. 2 shows the results obtained by plotting the actual yearly coal consumption of some eighteen office and loft buildings located in New York City, against the total glass equivalents of these buildings, as represented by the numerator of the quantity on the right-hand side of the equation given above. The coal consumed in these buildings was used for heating purposes only, as all light and power requirements are supplied by means of electrical energy purchased from the central station. The loft buildings that are included are not what are known as manufacturing lofts, but they are, for the most part, devoted solely to sales purposes. It will be observed that the value of K for this type of building is approximately 100, which is a very convenient figure for practical use. Pea coal was used in almost all of the buildings which appear on this chart, but data were secured on a number of buildings where the buckwheat coals, or various mixtures, were being used. All such cases—as would naturally be expected from the somewhat lower average calorific value of such fuels—fall above the average of the buildings using pea coal, but in some cases to a considerably greater extent than can readily be explained by the difference in the thermal values of the fuels.

In examining the chart shown in Fig. 2, it may be observed that only four of the buildings show any appreciable amount of divergence from the mean, as represented by $K = 100$. The divergence of these four cases can be readily explained. One of those falling below the line was due to a considerable portion of the building being vacant and only being partially heated; the other is a building where a considerable amount of heat results from the industrial use to which a portion of the building is devoted. The two cases above the line are due, respectively, to poor building construction and to inefficient operation of the heating plant.

The foregoing explanation of the methods that were followed in deriving the equation upon which this chart is based, will make it evident that this equation cannot be employed with any high degree of accuracy in the case of any building that is so peculiar in its construction as to widely differentiate it from others of its class; also where mechanical ventilation is to be employed, a certain allowance must be made for the loss of heat arising from this source, over and above that which the equation provides for in the form of natural ventilation due to air leakage. However, as a means of arriving at the amount of coal required to heat a given building, the writer has found this method to be of considerable value, and, owing to the many uncertainties that are invariably present in any heating problem, the use of this method will probably lead to results quite as accurate, in the average case, as those secured by the use of a much more involved and elaborate method of calculation.

A method of estimating the amount of coal required to heat a given building, as employed by a Chicago company that is engaged in the business of operating steam-heating plants, will be briefly outlined. This company has derived a formula based upon a heating season extending from October 1 to May 1, a total of 243 days, or 5832 hours. The average outside temperature during this period being 36 degrees Fahrenheit, the average difference between this mean outside temperature and an inside temperature of 70 degrees Fahrenheit, is 34 degrees. The amount of heat lost by transmission per square foot of glass per hour per degree difference in temperature is taken as 2 B.t.u., which is twice the amount usually allowed for this loss. The loss of heat by transmission through ordinary brick or tile wall is taken as one-tenth of the loss through glass, or 0.2 B.t.u. per hour per square foot per degree difference in temperature. Taking the number of heat units in a pound of steam as 1000, the following equation is obtained:

$$C = \frac{S \times 2 \times 34 \times 5832}{1000 \times e \times 2000} = \frac{S \times 0.2}{e}$$

(approximately)

where

S = Glass surface, plus one-tenth the wall surface (north and west exposures being increased 10 per cent.);

e = Number of pounds of water evaporated per pound of coal;

C = Tons of coal required for heating.

It will be observed that S in the above equation is equivalent to $\frac{W}{10} + G$, which may be written in the form $\frac{1}{2}\left(\frac{W}{5} + 2G\right)$. In this latter form the quantity within the parentheses is practically identical with the quantity representing the total glass equivalent as given previously in the equation developed by the writer. The quantity $S \times 2$ in the Chicago equation is, therefore, practically equivalent to the quantity $\frac{W}{4.5} + 2G$ in the writer's equation. In other words, the leakage loss in Chicago has been provided for by doubling the glass-transmission factor.

In Fig. 2 the number of tons of coal required for heating have been plotted against the quantity $\frac{W}{4.5} + 2G$ (which is practically equivalent to the quantity $S \times 2$ of the Chicago equation) for a number of commercial buildings located in Chicago, and it will be observed that these buildings fall fairly closely along a line for which the value of K is 50. In other words, the amount of coal required to heat a building with a given total exposure expressed in terms of equivalent glass, is apparently twice as great under Chicago conditions as under those existing in New York City, the value of K for buildings of a similar type located in the latter city having been found to be approximately 100. The question naturally arises, how is this observed difference to be reconciled with the apparent difference in the heating requirements of the two cities, as shown in Table 1? From this table it would appear that the heating requirements in Chicago are approximately 19 per cent. in excess of those existing in New York City, while the actual coal requirements are practically 100 per cent. greater in the former city than in the latter. This apparent discrepancy can undoubtedly be explained by taking two additional factors into consideration—one of which has a very material bearing upon the heat loss of a building with a given exposure, while the other has an important bearing upon the amount of coal required to offset a given loss of heat. The first of these factors is that of wind velocity; the second is that of evaporation, or the average number of pounds of water evaporated into steam per pound of coal.

The average velocity of the wind during the heating season in Chicago is a little over 18 miles per hour, while the average wind velocity in New York City during the months when heating is required is approximately 13 miles per hour. As the wind pressure varies approximately as the square of the wind velocity, the mean wind pressure during the heating season in Chicago is approximately twice that existing in New York City. Now the loss of heat by air leakage is naturally a function of the mean external air pressure that results from the velocity of the wind. Therefore, in order to show the effect which the higher average velocity of the wind in Chicago has upon the heating requirements of the buildings in that city, as compared with those of similar buildings in New York City where the average wind velocity is considerably lower, it is only necessary to estimate approximately the average relation of the heat loss due to leakage to the total heat loss under New York City conditions. In the latter city it has been found that the square feet of window surface of office and loft buildings averages about 20 per cent. of the total exposed wall and glass surface; hence, by referring to the expression for the total heat loss, $\frac{W}{4.5} + 2G$, it will be seen that the average heat loss from leakage, under New York City conditions, is approximately 35 per cent. of the total heat loss. Based upon the increased air leakage alone, the Chicago heating requirements are therefore 135 per cent. of those existing in New York City.

From tests made upon a vast number of Illinois coals by the United States Geological Survey, it would appear that a figure of 11,000 B.t.u. per pound may be taken as representing the average heat content of these coals as fired. Pea coal, such as is used in the majority of New York City buildings, will probably average something over 12,000 B.t.u. per pound. Consequently, if these different kinds of coal were burned with equal efficiency, the amount of Illinois coal required would be about 110 per cent. of the amount of pea coal necessary to supply an equal quantity of heat. It is very probable, however, that the actual ratio is more nearly expressed by 125 per cent., due to the fact that pea coal, when used in the average heating plant, will unquestionably show a considerably higher efficiency than that shown by such grades of soft coal as are commonly used in the heating plants of Chicago. Hence, if this contention and the foregoing assumptions are correct, we have an explanation of the fact that the amount of coal required in Chicago for heating a given building is twice what it would be were the building located in New York City; for

$$1.19 \times 1.35 \times 1.25 = 2$$

The heating requirements of a large number of Boston buildings have received careful investigation at the hands of Davis S. Boyden, of the Edison Electric Illuminating Company, of Boston, and as a result of these investigations he has developed a somewhat complicated formula for use in determining the amount of coal required to heat a given building. As the accuracy of this formula depends very largely upon what values are assigned to a number of variables, its use is necessarily confined to these who possess more than an ordinary knowledge of the subject of heating and who are capable of using a considerable amount of judgment in assigning proper values to these variables for any particular case.

In deriving this formula, the assumption is first made that 1 B.t.u. will raise 55 cubic feet of air 1 degree Fahrenheit, from which it follows that the heat units lost from a building per hour per degree difference in temperature will be

$$\frac{\textit{Volume of air} \times \textit{air changes per hour}}{55}$$

As it is usually impractical to estimate the amount of air displaced by partitions, floors, interior furnishings, etc., the term "volume of air" in the above expression is taken as the total gross volume of the building less 10 per cent. The above expression then becomes

$$\frac{\textit{90\% of gross vol.} \times \textit{air changes per hr.}}{55}$$

or

$$\frac{\textit{Gross volume} \times \textit{air changes per hour}}{60}$$

The next step consists of selecting the heat-transmission factors for glass and the materials of which building walls are usually composed. The loss of heat through a square foot of ordinary window glass per hour per degree difference in temperature is taken as 1 B.t.u., and the corresponding losses through brick and granite walls of the usual thicknesses are taken as 0.2 and 0.3 B.t.u. respectively. By thus providing for the loss of heat due to transmission, an expression is obtained for the total heat units lost per hour per degree difference in temperature. This expression is

$$\frac{\textit{Gross vol.} \times \textit{air changes per hour}}{60} +$$

$$\textit{sq.ft. of glass} + 0.2 \times \textit{sq.ft. of wall}$$

Instead of next proceeding to make an assumption as to the average difference in temperature between the outside and the inside air, which, together with an assumed number of hours during which heating occurs, would result in an expression for the total heat loss in B.t.u. during the heating season, the expression in the above form was applied to what was considered to be an average building that was satisfactorily heated and had neither too much nor too little radiating surface installed. This resulted in a factor which is considered as being constant for any given locality, the value for Boston being 5.4. This factor represents numerically the number of B.t.u. lost per hour per degree difference in temperature between the outside and the inside air for each square foot of radiating surface. Consequently, when the expression given above is divided by this factor, the quotient will represent the proper amount of radiating surface in square feet for any given building. This radiating surface is then divided by 130, which is considered to be the average amount of radiation that can be supplied by one boiler horsepower throughout the heating season under the conditions existing in Boston, and the quotient thus obtained represents the average boiler horsepower required during the heating season. The final equation, in its general form, is as follows:

$$\textit{Tons of coal per year} =$$

$$\frac{\frac{V \times a}{60} + C_1 \times G + C_2 \times W}{C_3 \times (130 - T)} \times L \times d \times$$

$$h \times \frac{34.5}{e \times 2000}$$

in which

V = Gross volume of the building, including basement if heated;
G = Square feet of glass surface, 10 per cent. being added for north and west exposures;
W = Square feet of wall surface, 10 per cent. being added for north and west exposures;
a = Average air changes per hour during heating period;
C_1 = Constant for glass = 1 for single glass;
C_2 = Constant for wall, usually 0.2 for brick and 0.3 for stone;
C_3 = Constant for local conditions = 5.4 for Boston;
T = Factor dependent upon relation the heating plant bears to the premises heated;
L = Factor for portion of building not heated, or for building not heated to 70 degrees Fahrenheit;
e = Average evaporation in pounds of steam per pound of coal;
d = Number of heating days during season;
h = Average number of hours of heating per day.

The values of h for different classes of buildings are given as follows:

Hotels, 15 to 16 hours.
Apartment houses, 12 to 14 hours.
Department stores, 10 to 12 hours.
Office buildings, 10 to 12 hours.
Theaters, 6 to 10 hours.

In the writer's opinion this formula is altogether too complicated for ordinary practical use. As previously mentioned, its accuracy, in any particular case, depends upon the value assigned to each of the several variables. A slight error in each of these assigned values might, by a cumulative action, lead to a total error of considerable magnitude. Moreover, the method employed in obtaining the so called constant C_3 (= 5.4 for Boston) introduces a considerable element of uncertainty, inasmuch as it would, conceivably, be an extremely difficult fact to determine absolutely whether a certain building had exactly the proper amount of radiating surface for its heating requirements.

While there are a number of other methods employed for estimating the heating requirements of a given building, they are all, of necessity, based upon the same general principles as those which have determined the methods described above, and they therefore differ from the methods described only in the manner in which they deal with the variables of which any heating formula is necessarily composed.

Continuous vs. Intermittent Heating

In reply to me in the Dec. 5 number of POWER, Mr. Evans chooses a building that is heated altogether by direct radiation while the original question was in regard to school buildings where an abundance of air is supplied for ventilation. In the report quoted it is correctly stated that when the building cools off, the radiation to the outside diminishes. Therefore, in intermittent heating, less heat is required, and, if there is any saving by continuous heating, it is because by this method the boilers are operated more economically. Mr. Powell's report then should not assume that at all times exactly 8500 heat units are obtained from a pound of coal because that would be the same economy at all times.

I contend that, in a school building which is fan ventilated, there is considerable saving in allowing the building to cool for a number of hours. In such a building, consider the heat to be divided into two parts, that necessary to heat the air for ventilation to 70 deg., and that radiated through the walls of the building. The first part, when school is not in session, can nearly always be dispensed with. This part is nearly always half of the total and often more than half. So that if the boilers are operated at the same rate of steaming, and therefore at the same efficiency, when school is not in session as when it is; there is enough heat to cause the temperature to rise rapidly.

There are so many things that enter into the consideration, that one has to be very careful in drawing conclusions from such tests as Mr. Powell made. For instance, it is a long way from correct to assume that the coal consumption for the 13 hours of the night is $\frac{13}{24}$ of the total consumption for 24 hours. To keep the factory at 70 deg. during the night would take more coal per hour than during the day, unless doors are opened very often in the day time. The night temperature is not only lower, but in the day time considerable radiated heat direct from the sun enters the building. If Mr. Powell would assume that it took a small per cent. more heat to maintain the building at 70 deg. during the night than in the day time, his figures would come out in favor of intermittent heating. But it is for the fan-heated school building with its comparatively short sessions that I claim the most saving.

H. H. HASTINGS.

St. Louis, Mo.

Issued Weekly by the
Hill Publishing Company
JOHN A. HILL, Pres. and Treas. ROB'T MCKEAN, Sec'y.
505 Pearl Street, New York.
122 South Michigan Boulevard, Chicago.
6 Bouverie Street, London, E. C.
Unter den Linden 71—Berlin, N. W. 7.

Correspondence suitable for the columns of POWER solicited and paid for. Name and address of correspondents must be given—not necessarily for publication.

Subscription price $2 per year, in advance, to any post office in the United States or the possessions of the United States and Mexico. $3 to Canada. $5 to any other foreign country.

Pay no money to solicitors or agents unless they can show letters of authorization from this office.

Subscribers in Great Britain, Europe and the British Colonies in the Eastern Hemisphere may send their subscriptions to the London Office. Price 21 Shillings.

Entered as second class matter, December 20, 1910, at the post office at New York, New York, under the Act of March 3, 1879.

Cable address, "POWPUB," N. Y.
Business Telegraph Code.

CIRCULATION STATEMENT

Of this issue 28,000 copies are printed.

None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.

Contents

Page

High Vacuum, Reciprocating Engines 72
A Boiler Room Argument..... 74
Smoke Prevention with Steam Jets.. 75
Why "Block" Stations Do Not Thrive 78
Peat 79
Application of Prof. Bone's Boiler.... 80
Electrical Reduction for Ship Propulsion 81
The Passing of One of Corliss' First Engines 82
Locating Defects in Direct Current Armatures 83
The Westinghouse Load Equalizing Hoisting Set 84
An Easy Problem in Star Connections 85
Rotary Converters vs. Motor Generators 85
A Simple Way to Put an Index on a Voltmeter 86
That Line Current Problem..... 86
Coal Required to Heat Modern City Building 87
Continuous vs. Intermittent Heating 90
Editorials 91-92
Readers with Something to Say:
Corrosion of Boiler Tubes in Nashville....A Clutch That More Than Paid for Itself....Homemade Auxiliary Heater....Sight Seeing in a City Factory.... Engine Needs Compression.... Feed Pipe Arrangement....On Keeping Record of Plant Performances.....93-95
Questions Before the House:
Engine Runs with Steam Valves Closed....Wrought Iron Tap.... Expert Advice.... Burning Fuel Oil....Vibrations of the Indicator Pencil....Central Station vs. Isolated Plant....Using the Firm's Stationery.... Engineer's Reference Book.... Emergency Die Stock 96-98
Inquiries of General Interest..... 99

POWER

One-Man Shifts in Power Plants

It is not uncommon in small plants to find one man performing the duties of both engineer and fireman, and in some large plants this is the practice on the night shift when a very small load is being carried. Where oil is burned under the boilers, it is possible to extend this practice to still larger plants.

While a slight reduction in the labor item is thus made possible, the wisdom of such a course is questionable. For, after all, the wages of an extra attendant (he need not be a high-priced man) are small when compared with the total power cost, and, viewed from the standpoint of providing additional protection, the increase in wages may be considered as cheap insurance.

Two men are required in the cabs of all locomotives and likewise in the pilothouses of ferryboats, this being considered a necessary precaution against accident should anything happen to the man at the throttle or the wheel. While in such event, more lives would be endangered in the case of a public carrier, still the impending danger to life and property is present, to a lesser degree, perhaps, in the case of a power plant.

To cite an illustration, some time ago the assistant engineer of the Pasadena municipal electric-light plant, who stood the night watch alone, attending the oil burners in the boiler room as well as performing his engine-room duties, was presumably struck by the governor and fell into the flywheel pit. This apparently happened about 1 a.m., but as the oil burners and the pumps were regulated so nicely the plant kept on running, the flywheel grinding all the time into the thigh of the injured engineer.

Not until long after daylight was it noticed that something was wrong at the power house, as the street lights were still burning. Upon investigation, the engineer was found dead in the flywheel pit, and a medical examination indicated that he had died about 5 a.m.; in other words, for four hours he was literally being ground to death. This fatality might have been averted had there been a second man on duty at the plant.

Viewing this incident from another standpoint, had anything gone wrong with the boilers or any of the machines while running without attendance, immeasurable damage might have been wrought to property and perhaps other lives endangered.

The whole question resolves into a compromise between economy and safety. If economy, in the long run, be considered as dependent upon safety, as we believe it should, then it would seem advisable, wherever possible, to have more than one man on a shift.

Steam Boiler Operation

Fuel, whether solid, liquid or gaseous, is burned most economically when just air enough to furnish the required oxygen for complete combustion is admitted to the furnace. If too much air is used, the products of combustion are chilled to just the extent that the heat which should be transmitted to the water in the boiler is used to heat the surplus air. While the combustion may be perfect with an excess of air passing through or around the burning fuel, about one-quarter of a heat unit will be used for each degree that every pound of excess air is heated in its passage through the furnace to the chimney.

It makes no difference whether the extra air goes through or around the fuel or is drawn in through the boiler setting beyond the furnace, the effect is the same in kind if not in degree. The cold air absorbs heat that should go to make steam.

If too little air is furnished, the combustion will be incomplete and a large percentage of the fuel will pass off in the form of a combustible gas which cannot burn in the furnace because of an insufficient supply of oxygen.

In many coal-burning power plants the boiler efficiency is low from one or the other of these causes. Where the grate area is larger than is needed to gen-

erate the steam used, the draft is restricted by the damper and much of the fuel, instead of being burned, is distilled and passes off unconsumed.

If the grate is not completely covered with fuel or if there are cracks in the setting, cold air is drawn in, reducing the efficiency just in proportion as the gases are cooled.

Many oil-burning furnaces are disappointing in their operation for the same reason. The oil is well atomized and burns with a clear, smokeless flame because it is thoroughly intermixed with air in sufficient quantity to make the burning complete, but owing to the facts that the air inlet to the furnace is too large and that the damper is opened too much, so much unneeded air is admitted that the boiler falls far short of its expected performance.

In a pumping station where there was an excess of grate area, a damper regulator was installed for the purpose of keeping the steam pressure more nearly uniform. This saved the fireman numberless periodical trips across the boiler room to the base of the chimney where the damper lever was located. With hand regulation the steam pressure varied from five to ten pounds either side of the desired point. A part of the time the damper was open too much for the demand on the boilers, but during this period the fire burned rapidly, giving the best results so far as combustion was concerned. When the damper was connected to the regulator and the draft was controlled by the steam pressure the damper never opened enough to make a brisk fire, and the fuel consumption was increased about ten per cent.

This was corrected by reducing the grate area until the required coal consumption per square foot of grate was such that the damper was wide open most of the time.

With the reduced grate area the furnace conditions were so much improved that the coal consumption was reduced six per cent. below that required by hand regulation.

In a tar-burning furnace the evaporation per pound of fuel containing 17,000 heat units was twelve pounds of water while running with the ashpit doors wide open. These openings were gradually reduced until all of the air admitted to the furnace passed through an area of twenty-five square inches. At this point the evaporation was fifteen pounds of water per pound of fuel, and further reduction in the air supply caused smoke.

These incidents tend to show the lines to be followed in steam-boiler operation.

All air in excess of that needed for the burning of the fuel should be kept out of the furnace. The combustion should be as rapid as possible, consistent with the demands for steam, and the grate area and air inlets should be as nearly as possible adjusted to obtain these conditions.

Steam Piping

The sole object of a steam pipe is to convey steam from one point to another. This fact is sometimes lost sight of, with the result that at the last moment the pipe is put up, usually along a row of building columns regardless of distance or accessibility. The broad principles to be observed in order to enable a pipe line to perform maximum duty are that it shall take as direct a course as practicable between any two points, have bends of as large a radius as possible, slope toward a certain point to provide for drainage and shall be only large enough to take care of the steam at a fair velocity. Very often circumstances compel to be neglected the first two of these principles, but they should all be considered as a basis for the design of every pipe line.

Adherence to the first principle results in a minimum amount of material required, as well as a minimum amount of labor for erection and, consequently, a lower initial cost. Low costs for repairs and maintenance will follow, as will also minimum losses due to radiation, etc., all of which naturally tend to keep down the operating costs.

The second principle, namely, the use of long radius bends, gives the steam a less retarded and obstructed path so that the drop in pressure at the discharge point is not unduly great, and numerous joints, which are always points of weakness in a pipe line and frequently afford pockets in which condensation will accumulate, are eliminated.

The question of proper drainage is always an important one and should never be overlooked. The fruits of neglect in this particular are often a blown-out cylinder head or burst pipe, caused by a slug of water resulting from the accumulation of condensed steam. If, because of local conditions, it is impossible to install a line without low points, provision should always be made for drainage at these points. Water in a steam line usually indicates improper construction or neglect to see that the traps, etc., operate properly and is a condition that should not be permitted.

In laying out a steam line, error more often occurs on the side of extravagance than economy when the size of the pipe to be put in is considered. This part of a power plant is so costly in comparison with the rest of the equipment, especially when large valves are employed, that every effort should be made to minimize such cost as much as maximum efficiency will allow.

The question of radiation and its consequent losses should also be a potent factor toward this end for, naturally, the smaller the surface exposed to the surrounding air the less will be the cooling effect. Advocating small-diameter pipes and high velocities for steam is, to a certain extent, inconsistent with minimum pressure loss; therefore, a compromise should be effected between the loss of heat (assuming, of course, that the line is properly covered) and the loss of pressure.

Beyond a certain small loss of pressure, any increase in pipe diameter affords so little reduction in friction and adds so much to the heat-reduction losses that the tendency toward the smaller pipe and a greater steam velocity, within limits, is amply justified from the operating side as well as from that of first cost; therefore, the expenditure involved in the installation of a line really larger than necessary is in practically every instance out of all proportion to the small gain in pressure.

The Delray boilers, with their 23,654 sq.ft. of effective heating surface and over 400 sq.ft. of grate, are the largest stationary boilers in the world. An interesting comparison is the record-breaking locomotive just built for the Pennsylvania R.R. With 7723.6 sq.ft. of heating surface and 96 sq.ft. of grate this immense boiler on wheels will generate nearly as much steam as the stationary boiler at its normal rating.

Readers with Something to Say

A letter good enough to print will be paid for. Ideas, not mere words, wanted

Corrosion of Boiler Tubes in Nashville

As the contributor of an article in POWER for Oct. 24 on corrosion, my attention has been called to the corrosion of boiler tubes in Nashville, Tenn. A new boiler was started up in April and by September all of the tubes had become pitted and had to be replaced. Commenting on boiler troubles in general, the Nashville *Banner* of November 2 says: "Some of the new piping that has sprung leaks has been taken to the office of the city water-works department, and in each case it was seen that the pipes were rusted out in spots, and not uniformly, as they would have been if the rusting had been the result of the action of the water. The fact that the rusting was in spots showed that there were flaws in the iron at the places where the rust came. If the pipe had been good and the rusting had been the result of the water, the entire surface would have rusted, for it is obviously impossible for water to be selective in its action and touch certain spots while not touching others."

At first this might appear to be common sense, but a careful study as to why a tube rusts more at one place than at another has developed the fact that the rising air bubbles liberated from the water stick fast to the surface of the steel tube, especially at those places where a roughness already exists. Air and water act simultaneously on the iron and rusting begins. The air bubbles liberated by the further deäeration stick fast at the rusted places so formed which, compared to the other parts of the surface of the tube, become very rough, thus causing an increasing spreading and deepening until a complete rusting through occurs. This shows that even if the tube is rusted at one place more than at another, the fault is not that the metal is more liable to rust in one place than another, but simply that it happened to begin there.

The Nashville *Banner* quotes Dr. Hollingshead, of Vanderbilt University, as follows: "As to the boilers, I think that the trouble will be found to be due partly to the fact that the old mud incrustation on the tubes is being worn off, but far more is it due to the use of the modern steel tube. The old charcoal iron tubes are not now used and steel tubes are not homogeneous. There are places in them where particles of various substances are found, and water acts on these places, causing electrolysis and decomposition in those spots. Any water would do this."

Without going into the relative merits of wrought iron and steel tubing, one fact which may apply to boiler tubes is that conditions today are much more favorable to electrolysis and corrosion due to the presence of stray electric currents than they were years ago when the wrought-iron tube was in use, and this is not disputing the opinion that the wrought-iron tube rusts less than the steel.

Coming now to the practical question of how to make the boiler tubes actually supplied last as long as possible, I believe that with the softened water supplied in Nashville the boiler tubes could be given some protecting coating as cement or graphite. I am not a steam-boiler expert and my only reason for this opinion is obtained from the new book of Spalckhaver and Schneider on the steam boiler ("Die Dampfkessel") in which it is said that a large number of boiler paints are being brought into the market, and nearly all of them are advertised as a universal means of protection regardless of the character of the boiler feed water and, besides preventing the corrosion, are supposed to overcome the formation of boiler scale and consequently to add materially to the saving in fuel.

It is pointed out, however, that even when the paint actually has one or the other effect, still its use is not to be advised in most cases since a coat of paint can never be maintained over the entire surface without interruptions. At any interruption, however, the destruction of the boiler plate would proceed as before. The coat of paint would easily be injured, especially if during the operation pieces of the boiler scale spring off, since the paint usually sticks to the scale and not to the metal. By pure feed water the inner coating of paint would remain longer unharmed and prevent the corrosion if the rust-preventing paint was spread on after the metal has been cleaned by sand blast. The preliminary cleaning of the wall is of especial importance since otherwise the corrosion would proceed underneath the coat of paint and by the increase in volume relative to the original condition occasioned thereby, the protecting coat would be lifted off, permitting the further entrance of the corroding agents.

Since the paints used are easily volatile and ignitable, their application on warm heating surface is not permissible for, under some circumstances, as by the use of open lamps, explosion of the gases formed may endanger the men engaged in painting. Oily and fatty substances are likewise not to be used as paints since they prevent the perfect contact between the water and the metal wall and, aided by the subsequent formation of boiler scale, can occasion the overheating of the metal wall or even buckling of the plates.

Cement has in many cases proved good as a paint for the inside; likewise graphite, if it is applied to the previously well-cleaned boiler plate and carefully rubbed on.

L. B. TAYLOR.

Toronto, Ont.

A Clutch That More Than Paid for Itself

Several years ago I was first assistant engineer in a textile plant having a pair of 22 and 40 by 72-inch tandem-compound Corliss engines turning 53 revolutions per minute with a direct-connected air pump and condenser. This outfit was known as unit No. 2. There was also an 18 and 36 by 48-inch single tandem compound Corliss engine turning 91 revolutions per minute with an independent air pump and condenser. This engine was unit No. 3. These units were side by side.

One day while everything apparently was running all right, one of the valve studs in the water end of the No. 3 air pump came out and the action of the water worked the stud into such a position that it caught lengthwise between the front cylinder head and the oncoming piston. The consequence was a break in the piston rod right next to the water piston. As unit No. 3 was operating at about 40 per cent. overload, it was out of the question to run it noncondensing and expect to carry all the load.

Inside the mill there was a friction clutch to couple the countershafts of the two units together in just such an emergency as this.

The clutch was thrown in and a wooden block was made to hold the governor of No. 3 in its highest position. Thus this

engine carried a maximum constant load and the No. 2 unit took care of the balance of the entire load and whatever slight variations occurred.

Although the clutch had never been used before, the saving that it effected by preventing a shutdown in this single instance amounted to many times the cost of its installation.

A. LAMARINE.

New Bedford, Mass.

Homemade Auxiliary Heater

In the plant where I am employed, there are two compound pumping engines of about 5,000,000 gallons combined capacity, four double return-tubular boilers, two air pumps and two duplex feed pumps, also two small flywheel air compressors. In fact, the equipment is supposedly in duplicate, but whoever designed it fell short on one of the most essential features, in that only one heater was provided for the entire plant, with not even an injector to be used as an auxiliary to tide over periods when the heater was being cleaned.

A short time ago, however, the man who had put the ban on any alterations or additions to the heater was relieved of authority and after the new superintendent had been on the job a short time, I was much surprised one day when he asked me if there was any auxiliary feedwater heater. I told him that there was none and that we did not even have an injector to use while washing out the heater.

"What provision do you think advisable?" said he.

"It will be necessary to do something at once," I replied, "for on examining the heater yesterday I found that all the piping inside of it was so badly pitted that the heater cannot perform its most essential duty, the filtration of the feed water." I suggested that an auxiliary heater be built and placed near the present one.

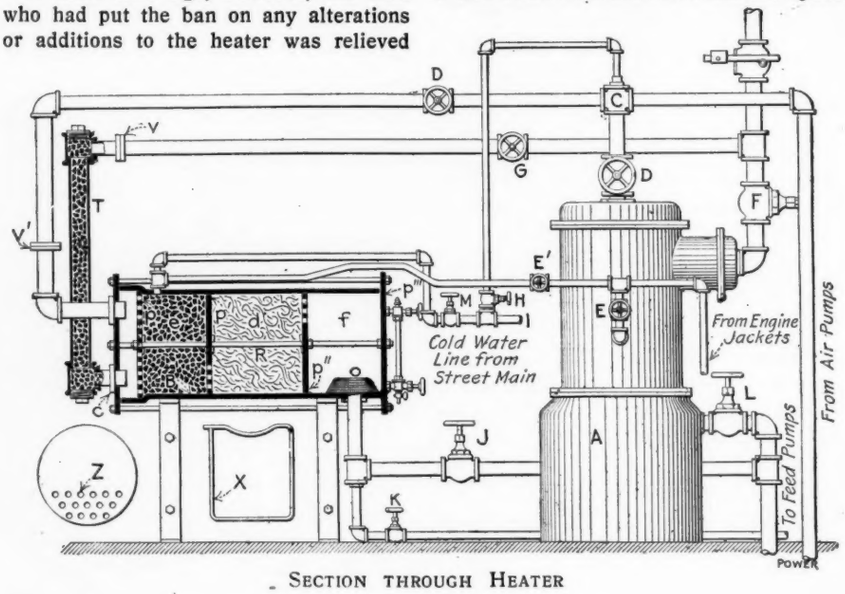
"All right, go ahead," said the superintendent.

The result is shown in the accompanying sketch.

The original vertical open heater is represented at *A* and at *B* is shown the new one, which was made of a piece of 30-inch cast-iron pipe. The ends were chipped smooth enough to take a gasket and then the four plates *p*, *p'*, *p"* and *p'"* were procured from a local boiler shop. The plate *p* was drilled full of ½-inch holes spaced about ½ inch apart; *p'* and *p"* were drilled as shown at *Z*, with the holes in *p'* at the bottom and those in *p"* at the top (these were drilled together in one operation). The rod *R* was run through the center of the three perforated plates, the nuts and keys holding the plates firmly in place.

Keys were used on the inside because threaded bolts soon corrode and also because it is impossible to turn a nut on them for any great distance, unless both the rod and the nut are of brass or copper.

In the space *f* was placed the galvanized-wire screen cover *O;* the space *d* was filled with excelsior and the space *e* with coke. There were no means at hand for making a baffle-plate oil separator; hence a piece of 8-inch wrought-iron pipe was attached, as shown at *T,* and filled with coke. This served to extract the oil, and by renewing the coke at each cleaning it gave very good results.



SECTION THROUGH HEATER

To remove the oil extractor it was necessary only to disconnect the flanges at *V* and *c,* and the coke could be removed or replaced by removing the plugs at either end of the pipe. The method of removing the front head and the perforated plates is obvious from the sketch. The plate *p"* is not removed unless for renewal. After the plates *p* and *p'* and the coke and excelsior have been removed, the hose is brought to play on the two filtering chambers, and then the filtering materials are renewed.

The two brackets which support the heater are shown in a side elevation at *X*. They are made of ⅜x3½-inch strap iron, with two 1-inch bolts extending through a 12-inch retaining wall.

The method of operating the heater is as follows: The water from the air pumps is forced through the line containing the cross *C* and is prevented from entering the vertical heater by the gate valve *D*. The exhaust from the auxiliaries is forced into the heater through the line containing the valve *G* and is prevented from entering the vertical heater by the valve *F*. The line containing the valve *E* is the steam-jacket drain line from the two engines, and is cut off from the vertical heater by the valve *E*. The line with valve *H* leading to the cross at *C* is the reserve supply, or cold-water line leading from the street mains, and the amount of water required is controlled by the valve at *M*. The valve *J* is in the line that supplies the water by gravity to the feed pump, and this is prevented from entering the vertical heater by the valve *L*. The valve at *K* is simply a drain to let the water out of the horizontal heater, and with the valve *J* closed and valve *K* open, all the mud and oil will find a way to the sewer without first dirtying the engine-room floor around the heater.

This heater has been working all right for three months, and the old heater is repaired and in good working order, but I do not use it simply because I believe in letting a good thing do the work while it will.

C. W. DUNLAP.

Depew, N. Y.

Sight Seeing in a City Factory

While on a visit to a certain large city, I was introduced to the superintendent of one of the factories there. He extended to me a cordial invitation to inspect his plant, which I gratefully accepted.

First, there was the office with large plate-glass windows, giving plenty of light, large clothes lockers for all of the office help, a large toilet room with white enameled wash basins, and combs, brushes, towels, soap, etc., all furnished by the company. There were two large fans for clearing the room of foul air. In short, everything possible was done to make the office force comfortable. The office employees worked only eight hours a day and received good wages.

We next went to the top floor where the articles of manufacture were given the finishing touches by the painters and packed for shipment. Here I found things a little different from the office, though very comfortable. There were eight painters and ten helpers or handymen, the painters receiving from $3 to $4 per day of eight hours, and the helpers from

$1.25 to $2. The paint shop and packing room had large windows on all sides, furnishing plenty of light and air. Each man had a small closet, just large enough for his coat and hat. There were three cast-iron wash sinks in the paint shop, each man furnishing his own soap and towel.

On the next floor was the carpenter and pattern shop. The carpenters were paid from $2.25 to $3.50 per day for nine hours; the pattern makers from $3 up to $5.50 for eight hours. Although their room had several large windows, the light and ventilation could have been improved at a small cost. On one side of the carpenter shop they had to use electric light on cloudy days. There was a large blank wall in which a window could have been cut, but the company would not go to the small expense. The foremen of the carpenter and the pattern shop each had a large clothes closet which they had built themselves from packing cases. The journeymen had no place to put their clothes except in their tool boxes and on nails driven in the wall. There were two sinks in the carpenter shop.

Next, we visited the machine shop, on the main floor. There I found men of half a dozen nationalities working 10 hours per day at wages ranging from $1.25 to $2.50 per day. The clothes lockers were a little larger than a bird cage. The men had to use pails (which they furnished themselves) to wash up, heating the water with a steam hose.

We then visited the foundry, where I found about the same class of men as in the machine shop. The wages were from $1.75 to $3.50 for nine hours. Their clothes were kept in a shed outside the foundry, and there was one dilapidated-looking sink in which to wash.

The superintendent then wanted to go back to the office, but I asked to see the engine and fire room. He said that it would be too hot for him, but I might go down if I thought I could stand the heat.

The engine room was about 18 or 20 feet below the level of the street. The thermometer stood at about 125 degrees, and not a window in the room; a small air shaft off at one end, with a fan belted from the engine, was the only means of ventilation. The fan was made and installed by the engineer.

Two Corliss engines direct-connected to generators furnished the power and the light for the factory, and there were two fire-tube boilers placed back under the sidewalk, with a grating for light and ventilation. The engineer had no place to hang his clothes, or to put packing, tools or anything else, and he had to use a pail to wash up. The floor was of rough, cheap cement made from one shovel of cement to seven of ashes, the top dressing being placed for two or three feet around each engine. The floor was put down by the engineer, who did the best he could with the materials at hand. He worked 12 to 13 hours a day, six days per week, and made his repairs, cleaned the boilers, etc., on Sunday. His wages were 20 cents per hour! There is quite a difference from the office to the engine room!

Is it just that an engineer, with so many lines depending on him, should be so poorly paid and so neglected even in the matter of necessities, let alone conveniences?

W. V. FORD.

Norwich, Conn.

Engine Needs Compression

Not more than 1000 miles from Boston is a paper mill containing two engines, one a double and the other a single machine, both running high pressure. The old chief engineer of this establishment boasts that he is running those units without compression, therefore making a great saving.

These engines are of well known makes, with piston rods held in a taper fit in the crossheads by two keys. About every two months the chief and the plant machinist, the latter receiving $6 for his day's work, put in one entire Sunday drilling and chipping out the keyways in the crossheads to allow for wider keys being inserted as the rods have pounded themselves loose in their sockets and the keys have been driven up to their heads. It is only a question of time when the slots will be so long that new crossheads will have to be ordered. In the shop there is a large pile of keys that have grown too small for the job.

To my way of thinking, if the chief would give the engines a little compression, the company would be the gainer in the long run.

EDWARD E. MOORE.

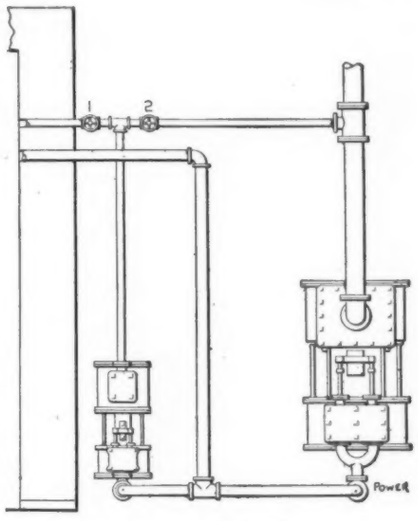
Atlantic, Mass.

Feed Pipe Arrangement

In a plant which consisted of a horizontal tubular boiler, a large duplex pump which discharged into a main leading to a standpipe, and an 8x6x6-in. duplex boiler-feed pump, the capacity of the feed pump was far greater than the evaporation of the boiler, and it was operated for but a few strokes and then shut down till the water level fell in the boiler.

This imposed an undue strain upon the boiler as well as the fireman, who had to force his fires previous to starting the feed pump, in order to prevent the falling of the steam pressure.

I overcame the difficulty by connecting the feed line to the main, as shown. By means of this arrangement the feed pump was run continuously, and the feed to the boiler was regulated by manipulating the valves 1 and 2. When both valves were open all of the discharge went into the main, since the pressure there was less than that of the boiler,



PLAN OF PIPING

but by throttling with valve 2 the desired feed to the boiler could be obtained.

R. S. MARTIN.

Fort Worth, Texas.

On Keeping Record of Plant Performances

I should be glad to get the ideas of other POWER readers on a systematic means for running various-sized installations.

It seems to me that the ideal way to run a plant is to be able at all times to determine just what each piece of apparatus is doing, and to do this I think that from time to time each piece ought to be calibrated according to a certain fixed standard, preferably based on what the apparatus did when new. Of course, a certain percentage of loss will have to be allowed for leakage, wear, etc.

In figuring the cost of light, heat, ventilation, etc., there is always the possibility of placing charges against these items which in reality belong somewhere else. To offset this I suggest a system whereby each engine, pump, etc., be first numbered, then rigged up for a test under actual working conditions and a careful note made of the data thus gained.

In these times of keen competition I think that engineers should take a greater interest, in their work than ever before, because as business competition grows keener so does competition in the engineering line by reason of greater facilities for learning. The uptodate engineer should be uptodate in reality when it comes to answering questions regarding each piece of apparatus under his care if it is at all possible to do so.

H. H. BURLEY.

Brooklyn, N. Y.

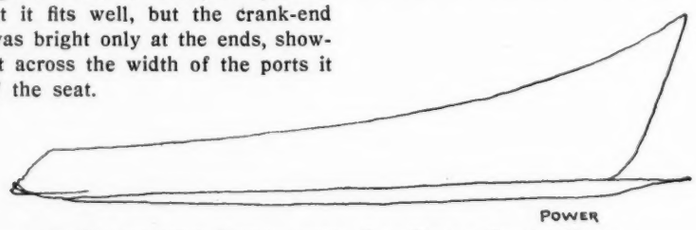
Questions Before the House

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues

Engine Runs with Steam Valves Closed

I have been much interested in the contributions under this head as I have charge of a Corliss engine which will run when the steam valves are closed. The accompanying diagram was taken while the engine was running under these conditions at a speed of 10 r.p.m. The engine has two eccentrics and it exhausts into a heating system against a back pressure of 15 lb. The diameter of the cylinder is 24 in. and the stroke is 42 in.

I removed both admission valves and found that the head-end one was true and bright the full distance across, showing that it fits well, but the crank-end valve was bright only at the ends, showing that across the width of the ports it was off the seat.



DIAGRAMS FROM ENGINE WITH ONE LEAKY STEAM VALVE

When the engine runs with the admission valve closed it slows up as it approaches the crank end of the stroke and then speeds up on the return. From this it is easy to tell at which end the leak is located.

GEORGE TAYLOR.

Millinocket, Maine.

Wrought Iron Tap

The letter in POWER for Nov. 21 about an emergency reamer attracted my attention and called to mind a job of the days before machine steel became common.

An old wood-planer was being over-

WROUGHT-IRON SCREW WITH FLUTED END

hauled. The elevating screws were worn out and the threads in the crossrail were stripped. New screws were made of wrought iron a little longer than the old ones, and the ends were fluted like a tap and case-hardened.

The holes in the crossrail, which was of cast iron, were then tapped out with these screws, and afterward the fluted ends were cut off from the screws. A first-class job was thus obtained.

JOHN A. COOK.

Birmingham, Ala.

Expert Advice

The editorial on page 788 in the Nov. 21 issue gives good advice when it says: "Advice which is valuable is worth paying for," but it should have gone a bit further and added, "but be sure that the advice is valuable before you engage it."

Usually, the engineer is capable of taking care of his plant in installing and operating new machinery, but sometimes a condition will arise in which he has had little or no experience; in this case the calling in of a consulting engineer (or expert advice) is a good investment, but care should be taken to get a man of good reputation and inquire into his previous work before engaging his services. The advice of a makeshift is dear at any price and if a machine is installed which is not suited to the duty it is to perform, it is a constant source of trouble and annoyance to the operating engineer.

I have had this experience and it still is a source of daily trouble.

We were contemplating the installing of an internal-combustion engine, generator and auxiliaries, and as our experience with this type was very limited, the firm engaged the services of a consulting engineer who came recommended as "the best in the state." After giving him all the data we could as to the duty the engine had to perform, etc., he left. In due time the specifications arrived and we advertised for bids. Plenty of engine builders wrote in for a copy of the specifications, but when the time came for letting the contract a very few builders were represented. They said that the specifications were so that but one company could build an engine to come up to the queer requirements. After some discussion the date for letting the contract was set a month later and new specifications were made out, with a slight change over the old ones, but still favoring this one firm of builders. We also gave a very flattering history of our plant, the town and its population.

When the contract was finally let this favored firm's bid was accepted, as the consulting engineer claimed it was the only engine which was fit for our service, although other bids gave a lower fuel consumption and a better operating guarantee.

The specifications stated that the engine should be in operation in 90 days after signing the contract; that if the contractor did not have the engine installed and operating in the specified time, he would have to pay $10 per day for every succeeding day the engine was not operating.

It was just five months later when the engine was finally started and the acceptance run was made. The fuel consumption was higher than the specifications called for, but the consulting engineer said that the fuel consumption called for in the specifications was too low and that the engine was doing well, better than he had expected. When asked about that $10 per day damages, the builders' representative pointed out that as there was to be no premium if they were ahead of the specified time, we could not hold them to this forfeit.

After this engine had been in service six months it proved to be too light for our service. It was under a constant strain all the time, the crankpin and crosshead-pin brasses wore far too fast and were subject to heating because of insufficient bearing surface; they needed keying up every day; the governor was unsatisfactory; in fact, the engine was not built for our service.

Later on, when I showed a copy of the specifications to a consulting engineer of high standing, he said they were so drawn up and worded that a coach and four could be driven through them.

About a year later we bought and installed another engine and generator, and with our previous experience we knew just what we wanted. Our superintendent took charge of this work and we got much better satisfaction than the time before.

This is no reflection on the consulting engineer in general, for we are at present employing one to install a water-filtering system, but before engaging his services we made careful inquiry as to

his ability for this kind of work and we wrote to the operating engineers of several plants where he had installed this type of filtering system, asking them what satisfaction his work and advice gave, and it looks as if we will get our money's worth this time.

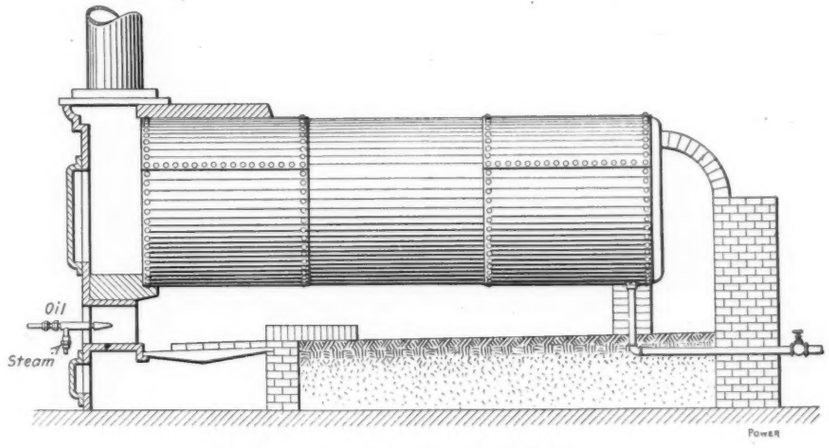
M. W. Utz.

Minster, Ohio.

Burning Fuel Oil

I noticed in a recent number that D. A. Steiner wished some information regarding a suitable design of furnace for burning fuel oil.

I have found the design shown in the accompanying figure to be quite satisfactory. Cover the entire grate surface with firebrick except for a space of 8 to 12 in. at the front, which should be left bare to admit air from the ashpit. Cut



Arrangement of Burner and Furnace

down the bridge-wall to the grate level and fill up the back combustion chamber as shown; have the filling take a slight slope up toward the rear. Protect the blowoff pipe well from the flame. Regulate the damper and ashpit doors according to requirements of load, etc.

John Weil.

Escondido, Calif.

Vibrations of the Indicator Pencil

Amos F. Moyer, in the Nov. 28 issue, while criticizing the writer's article under the above heading published on Oct. 31, attributes the undulations in the indicator diagram to the vibration of the spring rather than of the pencil arm. Mr. Moyer holds that the natural vibrations of the arm are too high.

In reply, the writer wishes to call attention to the fact that it requires two "beats" or oscillations to form a graphical wave, and, further, that the pencil arm is comparatively heavily loaded and supported in a complicated manner as well as loaded, and that a complete calculation of the vibration period would not show too high a frequency for the case in question.

The vibration period of the indicator spring, either free or loaded, is entirely too low for consideration. However, it is nearer the truth to say that both have their influence upon each other, and that all the reciprocating parts exert a modifying effect upon the wave form. Mr. Moyer's diagrams of Nov. 28 show this very clearly.

In reply to Charles F. Prescott's criticism of Dec. 5 on the grounds of economy, the writer offers the accompanying diagrams. These were taken from a 19½x21-in. four-valve engine in the shops of the Chicago & Northwestern Ry. at Lake Shore Junction, Wis. This engine is running at 200 r.p.m. under 110 lb. steam pressure. During a recent test of this engine by the writer and two engineers of the railroad, the following results were obtained:

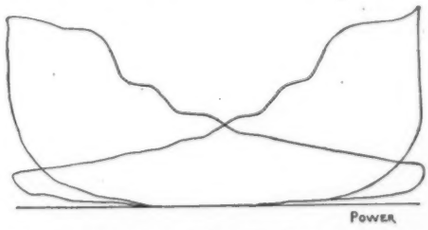
Load in percentage of rated load	Pounds of steam per i.hp.-hour
32.9	27.9
48.8	27.3
77.2	25.7
101.0	24.5
134.0	25.6

The steam used by the engine was passed through a surface condenser and weighed. The steam was also measured by a Gebhardt steam meter which gave a very satisfactory check on the weighed condensate. The economy speaks for itself, and it is good in spite of the jagged expansion line.

The writer has seen diagrams from English high-speed compound engines, with worse-appearing expansion lines than the one in question, developing an indicated horsepower-hour on 10.5 lb. of steam.

Mr. Prescott cites an experiment he made of soldering a strip of tin to the pencil arm, and because this did not remove the waves he claims the indicator is not responsible for them. It is not to be expected that this would remove the waves; it would, however, greatly alter them, as he may see by carefully looking over the diagrams presented. He holds that the sinuous expansion line is due to governor action; that is, unsuccessful attempts of it to close the valve. This would mean that the friction of the valve throws the weight arms through their entire range every quarter revolution, and does this by a succession of jerks, always steadying and returning to the exact position in time for cutoff No. 1.

Now, this is a very convenient governor for the hypothesis offered, but it would never control an engine. The shaft governor is powerful and no valve-gear can stand up while it receives such treatment. Were the governor blocked for a given point of cutoff, it would still show the same characteristic diagram. If these waves do actually represent an intermittent admission, why is it that the terminal pressure is as normal as though no reopening had occurred? The most vulnerable point of Mr. Prescott's hypothesis, however, is its narrow application; for numerous steam engines with widely differing types of valves and gov-



Diagrams from Engine Operated on 24.5 lb. of Steam per hp.-hr.

ernors, and various internal-combustion engines of both gas and oil, show similar waves in the expansion line.

No instrument made by human hands is perfect. They all have but a limited field and their peculiarities and shortcomings within that field. Every different make of indicator has its own individuality and characteristics which are also changing with age and wear. The engineer, by study and experience, must learn to recognize the fundamental facts from the hurried record; as the child, having learned the ideal letter forms, must learn further to recognize these same letters and words in the hasty manuscript of its elders.

J. W. Taylor.

Massillon, Ohio.

Central Station vs. Isolated Plant

I have been interested in the discussion of the above subject in Power as I have had some experience with the central-station solicitors.

I have lost one position to them and have been able to keep one contract from them. In the first case it was a brickyard plant running only in the summer months and shut down on rainy days. As the owners had no need for steam except to drive the engine, I could

not put up much of an argument against the central station. I know, however, that since changing over to the central-station service, as far as expenses are concerned, they just about break even with the cost of the old system.

The second case was that of a tenant on one of the floors of the building which my present plant serves. This man thought that he might reduce his expenses by buying outside current. He requires about 10 hp. to drive some shoe machinery. The central-station solicitor came in and looked over his machines and said that if they were all running all of the time it would take about 18 hp., but his average would not be over 10. He would let him have current at 3 cents per horsepower-hour and guarantee that it would not cost more than $30 per month.

As near as I could figure the same proposition, 3 cents per horsepower for a 10-hour day would be $3 per day, and with 26 working days in a month, it would be $78 per month.

It seems to be the same way everywhere. I have talked with engineers who know more about the business than I do, and all of them say that they cannot figure with the central station and understand it.

L. W. CHADWICK.

Bridgewater, Mass.

Using the Firm's Stationery

In the Nov. 28 issue, Mr. Utz gives his experience in using the firm's stationery. My experience has been that this oftentimes gives the letter too much of an air of responsibility. Some time ago, while reading the advertising section of POWER, I decided to try a sample of a certain well advertised grease which prior to that time I had never used; at the time the grease in use was not giving entire satisfaction. So I used the firm's stationery to request a free sample, together with a grease cup, and stated in the letter that the grease was to be sent to my private address and not to the company's.

In about a week the supply clerk told me that he had just received a package addressed to me in care of the firm. It proved to be my can of grease. I used it and found it to be just what I was looking for, but, although I recommended it to the purchasing agent, I could not get him to order a trial barrel at that time.

A few days later I received a letter from the grease company, inclosing a stamped envelope, asking for the results of my trial sample. I wrote them that it was a very good grade of grease and thought it would give much better results than the grease I was then using. This I considered a purely private affair as I had sent for the grease and tried it to satisfy my own curiosity as to its merits in my plant.

About two weeks later the superintendent received a letter from the grease company, inclosing a copy of my letter on the firm's letter-head and signed by myself, recommending the grease, and urged them to buy a barrel. The superintendent called me to his office and asked me to explain myself. I told him and still recommended the grease as the best I had ever used for that plant and urged him to buy a barrel. He thought he smelled graft from the grease company and called it an underhanded way to get the grease tried; he would not order it on any conditions. We used about three barrels a year and consequently the use of the firm's stationery lost the grease company a good customer.

The grease would have been used if its makers had not employed the means they did to get the attention of the firm. Since then in sending for samples I purposely leave out the firm's name but state that if the sample proves satisfactory to me under the conditions I wish to use it I will call the company's attention to it; if it is not satisfactory I do not care to have them bother the company about it and bring me into the matter.

Since I have stopped using the firm's stationery when sending for samples, etc., I have had no trouble. Of course, when prices, etc., are asked and it is the intention of the company to purchase, then the firm's stationery is used.

J. C. HAWKINS.

Hyattsville, Md.

Engineer's Reference Book

Reading of late in POWER of the method of compiling one's own reference book, I must say that I also passed through the over-enthusiastic state noted by Mr. Bailey in the issue of Nov. 21.

However, I do not regret it one moment, for it is one of the best ways possible to impress upon a beginner the importance of delving into the root of whatever the subject at hand may be.

In the first place, it is usually something along his line of work, and important that he should know it, for it is understood such a reference book pertains only to his line of work, thorough in all its phases.

Too many times the compilers of these home-made reference books copy only the mechanical, electrical, hydraulic and allied topics, forgetting that the insertion of business methods is equally important. It is not a difficult task to figure how to work overtime, plus Sundays and holidays, but to eliminate those extra hours as much as possible is an important factor.

The collecting of data of any nature is for our own personal betterment and advancement; therefore, why stop at the dynamical side of the subject? While a reference book does not mean a collection of these, but rather abbreviated forms, points relating to social, financial and ethical phases of it should not be omitted. If one inquires regarding any successful man's career he will find that he has not neglected the observance of any one of the above points.

My practice now is the same as outlined by Mr. Bailey—"Copy all of some article into my book, but not unless it is of great importance or something that cannot be found in the handbook. After all, the handbooks contain a good deal of reliable information and are hard to beat." POWER has of late been treating of the low wages of engineers, especially in proportion to their hours, and in particular with the "higher-ups" in the engine room. The reason for this is at once made manifest in this brief sentence: There is too much mechanical and not enough business engineering.

Many engineers simply get in a rut, though they are apparently unaware of it. In New York City, engineers can be had for from $18 to $20 per week, which condition is pretty general all over the country, and it includes engineers in fairly good-sized plants and smaller but more complicated plants.

A cold-storage engineer who held a first-class license in Illinois told me that he would not work at the operating end as there was "nothing in it," and that he could more than double his earnings in laying out and erecting refrigerating equipment. It is claimed that New York City alone has 1000 engineers following other lines of work, low wages plus central-station inroads being responsible for much of it.

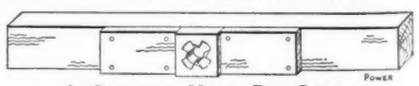
Had many of these engineers studied other branches relating to their work—though, to many of them, at the time apparently foreign to it—they would still be following their natural bent in life and with greater success. Those who have done so are continuing their engineering work and receiving a salary in keeping with their responsibility.

SAMUEL BROUTHERS.

Springfield, Ohio.

Emergency Die Stock

Recently I saw a description in POWER of an emergency die stock. Here is one I made in about ten minutes. I bored a hole in the center of a 2x4-in. board, the same size as the pipe I wanted to thread. Then, I nailed some blocks on



A QUICKLY MADE DIE STOCK

to keep the die from turning. When I wanted to cut a smaller pipe I nailed a block on the back side and bored a hole in it the same size as the pipe I was to cut. I kept the pipe from turning with a pipe wrench, and cut the best thread I ever made.

F. W. BAIR.

Hancock, Mich.

Inquiries of General Interest

Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it

Barometer Reading and Lift of Pump

On a mountain where the atmospheric pressure is 12 lb. per square inch, how high would the mercury stand in the barometer, and to what height would it be possible to raise water by a suction pump?

P. P.

The relation between the barometer reading and the air pressure in pounds per square inch may be expressed as

$$\textit{Barometer reading} = \frac{\textit{atmospheric pressure}}{0.4908}$$

Applying this to the present problem,

$$\textit{Barometer reading} = \frac{12}{0.4908} =$$

$$24.43 \textit{ in. of mercury}$$

A column of mercury 1 in. high will balance a column of water 1.133 ft. high. Therefore 24.43 in. of mercury will balance

$$24.43 \times 1.133 = 27.7 \textit{ ft. of water}$$

This is the theoretical height to which water could be lifted by the suction pump if the valves did not leak and there was a perfect vacuum in the suction chamber. In practice, it is seldom possible to obtain over 85 to 90 per cent.; therefore, the probable lift in the present case would be from 23.5 to 25 ft.

Gate Valve between Relief Valve and Exhaust Header

The atmospheric exhaust of our engines and auxiliaries is piped to a common header, making it impossible to inspect or repair the relief valves without shutting down the plant. Would it be safe to install a gate-valve between the relief valves and the exhaust header?

R. S. K.

Putting in valves as suggested is not unsafe if proper precautions are taken against their being closed by some careless or unauthorized person. This can be done by removing the handwheels and locking them open.

Boiler Horsepower

How is the horsepower computed of a 5x18-ft. return-tubular boiler having forty-four 4-in. tubes?

F. J. R.

The heating surface of a horizontal return-tubular boiler is one-half the area of the shell, the area of all the tubes and the area of one head minus twice the area of one end of all the tubes. In this case, one-half the area of the shell is

$$\frac{5 \times 18 \times 3.14}{2} = 141.3$$

The internal area of forty-four 4-in. tubes 18 ft. long is

$$\frac{11.75 \times 216 \times 44}{144} = 775.5 \textit{ sq.ft.}$$

The area of one head is

$$5 \times 5 \times 0.7854 = 19.63 \textit{ sq.ft.}$$

Twice the area of the ends of all the tubes is

$$\frac{12.56 \times 88}{144} = 7.68 \textit{ sq.ft.}$$

$$19.63 - 7.68 = 11.95 \textit{ sq.ft.}$$

Adding these together gives the total heating surface of the boiler.

$$141.3 + 777.5 + 11.95 = 930.75 \textit{ sq.ft.}$$

Allowing 10 sq.ft. of heating surface per boiler horsepower, the horsepower of the boiler will be

$$\frac{930.75}{10} = 93.07 \textit{ hp.}$$

Horsepower Constant

What is the rule for finding the horsepower constant of an engine? Give an example.

A. A. B.

To find the horsepower of an engine from a number of diagrams it is convenient to figure the horsepower developed per pound of mean effective pressure, and multiply this result, which is the horsepower constant, by the mean effective pressure of each diagram to find the horsepower developed from that diagram. This can be done by considering the mean effective pressure in the formula as 1 lb. As it is unity it may be left out.

The formula is as follows:

Multiply the area of the cylinder by the stroke in feet and the number of strokes per minute; divide this product by 33,000. The quotient is the horsepower per pound of mean effective pressure, or

$$\frac{ANS}{33{,}000} = \textit{hp. per lb. m.e.p.}$$

This horsepower constant multiplied by the mean effective pressure is the horsepower developed.

Assume an engine 22x48 in. running at 70 revolutions per minute. The mean effective pressure obtained from one indicator diagram averaged 37 lb.; from another diagram the average pressure was 32 pounds.

The area of the cylinder is

$$22 \times 22 \times 0.7854 = 380.13 \textit{ sq.in.}$$

The piston speed is

$$2 \times 48 \textit{ in.} = 96 \textit{ in.} = 8 \textit{ ft.}$$

$$8 \times 70 = 560 \textit{ ft.}$$

$$\frac{380.13 \times 560}{33{,}000} = 6.45 \textit{ hp. per lb. m.e.p.}$$

Multiply the average unbalanced pressure of the first diagram by 6.45.

$$37 \times 6.45 = 238.65 \textit{ hp.}$$

From the pressure obtained from the second diagram the horsepower developed would be

$$32 \times 6.45 = 206.4 \textit{ hp.}$$

Pressure on the Guides

What is the maximum pressure on the guides of a slide-valve engine when the initial pressure is 90 lb. per square inch?

A. F. D.

Multiply the area of the piston in square inches by the pressure per square inch when the crank is at right angles with the guides. The product will be the horizontal push on the crosshead at this point. Divide the length of the connecting-rod by the length of the crank, and subtract 1 from the square of the quotient. Divide the horizontal thrust found as above by the square root of the remainder. The quotient will be the maximum thrust at right angles to the guides due to the steam pressure.

Assume an engine having a cylinder diameter of 12 in., a stroke of 14 in. and a connecting-rod 35 in. long. Applying the dimensions to the rule it may be thus expressed:

$$(12 \times 12 \times 0.7854) \times 90 = 10{,}179 \textit{ lb.}$$

The horizontal push on the crosshead at this point is

$$\left(\frac{35}{7}\right)^2 - 1 = 24$$

$$\frac{10{,}179}{\sqrt{24}} = 2077 \textit{ lb.}$$

the maximum thrust at right angles to the guides at 90 lb. initial pressure.

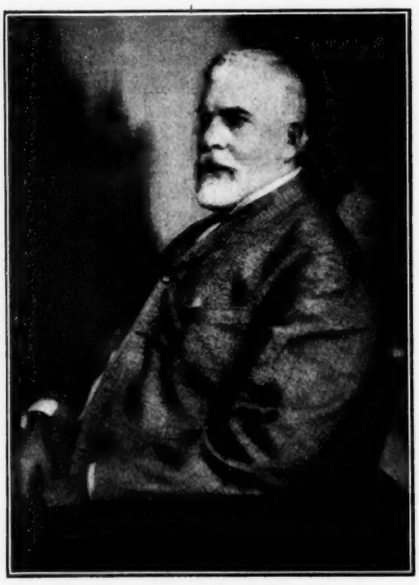
The largest electrical show in the world will be held in Boston in September. The Mechanics building, which will contain it, seats over 100,000 people at one time, and has 105,000 square feet of exhibit space.

OBITUARY

James McBrier, president of the Ball Engine Works, and a prominent business man, died at his home in Erie, Penn., on Jan. 4, at the age of 78. Mr. McBrier was born in Allegheny and received his early education in the common schools. In 1887, in company with several other business men, Mr. McBrier organized the Ball Engine Works, of which he was elected president, retaining that position until his death.

Richard Teller Crane, founder and head of the Crane Co., died at his Chicago home on Jan. 8.

Mr. Crane was born in Paterson, N. J., on May 15, 1832. The family being too poor to give the children much of an education, Richard started to work when nine years of age and after six years he found employment in John Benson's brass shop in Brooklyn in 1847. Four years later he entered the machine shop



RICHARD T. CRANE

of the Taylor Printing-Press Works, and later that of Hoe & Co., where he learned the machinist's trade.

In 1855, he went to Chicago and after obtaining advice and material assistance from his uncle, Martin Ryerson, he built a small brass shop on the corner of Lake and Market Sts.

Mr. Crane's policy from the first was to put his earnings back into the business, and he had sufficient courage to extend the business as rapidly as his means permitted. As a result, the business grew rapidly and steadily.

Some of the special lines in which Mr. Crane actively engaged were the manufacture and installation of elevator equipment, piping, valves, fittings and air-brakes. Elevators were made by the Crane Co. as early as 1867, and this business grew so rapidly that it was soon crowding other work out of the machine shop. In 1886 the elevator part of the business was separately incorporated as the Crane Elevator Co., and with a view to concentrating on the valve and fitting business the Crane Elevator Co. was sold in 1895.

Mr. Crane always took a lively interest in the welfare of his employees. Prior to the establishment of a pension system by the Crane Co., he personally pensioned employees whom sickness or old age overtook before they could lay by a competence. Through the Crane Co. in 1900, Mr. Crane gave to each employee 5 per cent. of the total amount of the employee's earnings during the previous year as a New Year's present. This had been his practice each year since, except that for the last eight years the amount was 10 instead of 5 per cent.

Mr. Crane took an active interest in social, economic, political and educational affairs and was prominently identified with many important movements. He was a student of and writer on educational problems. In all of his writings he placed great emphasis upon the distinction between an educational system adapted to meet the wants of the masses and a system suitable for training only a favored few. He laid especial stress upon the importance and practical value of manual training in the grade schools. In recognition of Mr. Crane's interest in the public-school system the Chicago board of education a few years ago named a new school the R. T. Crane Manual Training High School.

Indicted for Neglect

On Jan. 2, Francis S. Ward, commissioner of public works, at Buffalo, N. Y., and his chief assistant, Henry L. Lyon, were indicted on a charge of manslaughter in the third degree.

It is charged that their negligence in the preparation of plans for the city's power-plant building, which collapsed last June, caused the death of eight workmen.

Instruction in Heating and Ventilation

The evening school of the Harlem Young Men's Christian Association, 5 West One Hundred and Twenty-fifth St., New York City, opened an evening class in heating and ventilating on Wednesday evening, Jan. 10. This is the third season for this course. The instruction is provided especially for engineers, draftsmen, mechanics and salesmen of heating appliances. The course will consist of lectures, demonstrations of systems and appliances, visits to institutions for inspecting the operation of various heating and ventilating devices, discussions and answering pertinent questions.

Classes meet on Wednesday evenings each week, from 7:45 to 9:45. The course will extend over two terms of 11 weeks each. Membership in some branch of the Young Men's Christian Association is a preliminary requirement. C. A. Fuller, heating and ventilating engineer, is instructor.

SOCIETY NOTES

The Minnesota Electrical Association will hold its next convention in Minneapolis on Mar. 20 to 22. The Northwestern electrical show will be in progress at the same time.

The twenty-fourth annual convention of the American Boiler Manufacturers Association, together with its associate members and the Supplymen's Association, will be held in New Orleans, La., Mar. 12 to 15, at which time some very important papers will be presented to the association, and other business of interest to all the boiler manufacturers in the United States and Canada and supply houses dealing with the boiler and tank industry. An extensive program of entertainment has been arranged, and a large attendance of boiler manufacturers and supplymen from the United States and Canada is expected. Further information can be had by applying to F. B. Slocum, secretary, Supplymen's Association, of the American Boiler Manufacturers Association, the Continental Iron Works, Brooklyn, N. Y.

PERSONAL

George J. Henry, Jr., until recently chief engineer of the Pelton Waterwheel Co., San Francisco, Calif., has resigned in order to establish his own office in that city as a hydraulic and mechanical engineer with the idea of engaging in the manufacture of tangential waterwheels, turbines and power-plant specialties.

J. H. Ehlers, of Libby, Mont., in charge of mining and water-power development work at Yakt Falls, contemplates the building of an electric railroad in the Yakt Basin and the use of modern electric logging and manufacturing appliances in utilizing the immense stands of timber in that locality. It is expected to develop 3400 hp. at the falls, which will also be used in the operation of the mines at Sylvanite.

BOOKS RECEIVED

POWER-HOUSE DESIGN. By John F. C. Snell. Longmans, Green & Co., New York. Cloth; 448 pages, 5½x9 in.; 181 illustrations; plates; tables. Price, $6.

MODERN AMERICAN TELEPHONY. By Arthur B. Smith. Frederick J. Drake & Co., Chicago, Ill. Leather; 790 pages; 4x7 in.; 470 illustrations

Moments with the Ad. Editor

Out in western Colorado is Grand Mesa. It is the highest mesa in the world.

It is a beautiful rolling plain, 25 miles long, 5 to 10 miles wide, lifted 10,000 feet above the sea, with its edges dropping down in almost perpendicular cliffs. A few steep wagon and cowboy and wild-horse trails lead up from the valley through little canyons to the top.

The top of Grand Mesa is covered with spruce, fir and western pine and dotted with deep cold lakes that teem with trout. These lakes are said to fill the craters of dead volcanoes. Up there are the Government's Fish Hatcheries, Forest Ranger Cabins and the reservoirs of co-operating irrigating companies that supply water to the fruit ranches below.

And so it seemed necessary, finally, to establish telephone connections with the outer world.

The State Telephone Company surveyed a line, got some guarantees—then started to build. They cut spruce poles up on the forest reserve—each pole like an arrow, and these were set in long lines up the reaches of the mountain, straight enough to make your head reel. Not a pole out of line; dynamite blew rocks to flinders when they got in the way. That telephone line was a thing of beauty.

The little "co-op" phone company built a line, too. *They* didn't have the money to haul spruce poles off the Forest Reserve. Instead, they had to use the small twisted mountain cedars that grew near, and they paid a little something to the hard-up homesteaders along the way to cut these, peel, and drag them to the line of survey.

That co-op phone line was a joke—in looks. Ugly twisted poles, with big knots like boils sticking out all over—sometimes hardly tall enough to let the wires clear a passing load of alfalfa or fruit boxes. Running alongside the other line, it looked as if it might have been built by school kids at recess.

But people around there believed the co-op. It gave better service, they said, and it reached folks in lonely places where the State phone wouldn't build.

This is half the story.

About a year passed. Then, last spring, a wild gale one night rushed up the valley. After it was over, dozens and dozens of tall straight spruce poles of the State phone company were flat with wires snapped off. They had rotted just below the level of the ground and the wind tipped them over like as many weeds.

The ugly little cedar poles didn't snap. And none of them ever has

That big company was forced to go out on its line and set heavy cedar stubs by the foot of its broken poles, and bolt them fast. They have been at that job ever since, up and down the line, bolstering up their fine tall poles with rough little cedars of the same kind as the competing company built with in the first place. That fine showy feat of telephone engineering got to be a joke in the country—not in *looks*, but in *fact!*

The little company gained subscribers; the big company lost.

And the way the people stood by the little concern in its first struggle shows the spirit out in the new West, and is a good lesson to be read by everyone. The people out there have been fooled a good many times. Now they say, "Wait." When outsiders joshed the ugly little co-op phone line they said "Wait—just wait a little." They wanted to be shown; they were.

Wait to be shown! That's the idea of today, and here's the application:

POWER *has waited* till it has been convinced that products advertised in this Selling Section are genuine. POWER *had to be shown*, before it would run any of these advertisements.

But YOU don't have to wait—*the fact that the ad is here is a guarantee.*

NEW EQUIPMENT

The Toledo (Ohio) Rys. & Light Co. will erect a new power plant.

The St. Jovite (Que.) Power & Electric Light Co. will equip a new plant.

Ashburnham, Mass., will install a new water system, to cost about $50,000.

Swift & Co. will equip a new $300,000 cold-storage plant at Vancouver, B. C.

The Standard Fisheries Co., Calgary, Can., will equip a new cold-storage plant.

The Inketter-Myers Co., Hamilton, Ont., will equip a new ice-making plant.

The Rock Island R.R. Co. has started work on its power house, at Dallas, Iowa.

The Philadelphia (Penn.) Electric Co. will erect a power plant at Tioga and J Sts.

Woodlake, Minn., is considering the installation of a municipal electric-light plant.

The Crawford Locomotive & Car Co., Streator, Ill., is enlarging its power house.

Wethersfield, Conn., has voted to issue $25,000 bonds for installing a new water system.

The B. S. Sprague Electric Co., Marietta, Ohio, will buy some electrical equipment.

H. L. Mize, Cordele, Ga., will erect an addition to his ice plant and install new machinery.

Devils Lake, N. D., will issue $33,000 bonds for the erection of a municipal lighting plant.

Atchison, Kan., is considering installing a municipal lighting plant. C. D. Walker, mayor.

The City Council, Reynolds, N. D., is considering the installation of an electric-light plant.

F. P. & C. A. Donahue, Springfield, Mass., are erecting a boiler house in the rear of 227 Main St.

The Interstate Elect Mfg. Co., Sioux City, Iowa, will erect an electric-light plant at Galva, Iowa.

Antioch, Calif., is contemplating the establishment of a municipal electric-light and power plant.

McCleary, Walling & Crouse, Amsterdam, N. Y., is planning to erect a new and larger power plant.

The Tucumcari (N. M.) Light & Power Co. has had plans prepared for the installation of a power plant.

Plans for addition to the Seelbach Hotel, Louisville, Ky., include considerable new power-plant equipment.

The Telluride (Colo.) Power Co. has been granted a franchise for a light and power plant, at Montpelier, Idaho.

The trustees of the Mass. Training School, Boston, Mass., contemplate erecting a new power and lighting plant.

Falmouth, Ky., has voted $7500 bonds for the erection of an electric-light plant. Anderson & Frankel, Lexington, Ky., architects.

The engine house and tipple at mine No. 21, of the Vandalia Coal Co., of Terre Haute, Ind., at Linton, Ind., was destroyed by fire.

The City of Osceola Ark., has taken over the electric-light plant and will build a new power plant and will install new machinery.

Power-plant equipment will be required for the new St. John's Hospital, to be erected at Cleveland, Ohio. Wm. Lougee, architect.

The Bald Mountain Portland Cement Co., Rome, Ga., will erect a $650,000 plant in Aragon, Ga. A power plant of 30,000 hp. will be installed.

The Needles (Cal.) Ice Co. has been incorporated, with $125,000 capital, to manufacture ice. Incorporators, J. T. Murphy and N. A. Sterry.

The People's Ice Co., Helena, Mont., recently organized by L. C. Nelson, H. A. Meyer and others, is planning the establishment of an ice plant.

The Maine Hydraulic Power Co., Bath, Me., has been incorporated to build a dam and power plant at Bath. William S. Maxwell is at the head of the company.

Henry L. Doherty & Co., 60 Wall St., New York, have purchased electric-light plant of Isadore Newman, at Galveston, Tex., and will make extensive improvements.

The City Electric Co., San Francisco, Calif., has had plans prepared for a new electric substation. Samuel Napthaly, Shreve Building, San Francisco, engineer.

The Santa Fé Ry. is planning the erection of an ice-making and refrigerating plant, at Sweetwater, Tex. L. J. Prather, Santa Fé, refrigerating department, is in charge.

The New York, New Haven & Hartford R.R. will extend the electrification of the road from Stamford to New Haven, and will erect a large power house in the latter city.

The Buckeye Light & Power Co., Covington, Ohio, has been incorporated with $40,000 capital to build an electric power plant by J. H. Marlin, Hugh C. Marlin, A. W. Landis.

The Oldenburg Electric Light, Power & Water Works Co., Oldenburg, Ind., has been incorporated with $5000 capital by George Holtel, Sr., N. J. Gloshen, B. J. Kessing, etc.

The Spokane & Inland Empire R.R. Co. contemplates the installation of a 500-kw. motor-generator set. C. L. Bankson, Terminal Building, Spokane, purchasing agent.

The Sacramento (Calif.) Water Co., recently incorporated with $1,000,000 capital, has acquired water properties at Salmon Falls, near Folsom, Calif., and will erect a plant.

The city council, Stanton, Neb., will build an addition to its power house and purchase a 100-hp. steam engine and 125-hp. boiler. C. A. Hickman, engineer, is preparing plans.

The Rapid Transit Interurban Co., Tecumseh, Okla., is planning the installation of a large power plant at Sulphur, Okla. Edgar M. Graham, Muskogee, Okla., is chief engineer.

Bids will be received by the board of public works, of Anderson, Ind., until Jan. 2, for installing a new turbine at the municipal electric plant. About $30,000 will be expended.

The Russell Co., of Dayton, Ohio, is interested in an enterprise formed for the purpose of building a dam and power plant on the Big Miami River, at Woodsdale, to cost over $500,000.

The Portland (Ore.) Ry., Light & Power Co. will expend about $1,500,000 in additions and improvements this year. A new power plant and substation on the west side of the city is planned.

The plant of the Booth Fisheries Co., at Morris St. and Lake Ave., Duluth, Minn., was damaged by fire to the extent of about $15,000. Engines, boilers and cold-storage machinery were ruined.

A power plant will be erected in connection with the new buildings to be erected for the Occidental College, Los Angeles, Calif. Myron Hunt, Union Trust Building, Los Angeles, architect.

The Western Union will erect a 2-story building, at Broadway and Dey St., New York, to cost about $3,000,000. Power plant will be installed. Wm. W. Bosworth, 527 Fifth Ave., architect.

The Pacific Ice Rink Co., Los Angeles, Calif., recently incorporated with $100,000 capital, is planning the erection of an artificial-ice skating rink and refrigerating plant at Luna Park, Los Angeles.

The York Manufacturing Co., Saco, Me., is building a new power plant, which, when completed, will be the largest in Maine. Thirty-six large boilers will be installed in place of the 24 now in use.

The Bakersfield (Calif.) Water Co., recently organized, has acquired the plant of the Sumner Water Co., at East Bakersfield. Will increase capacity of plant and install new electric pumping machinery.

The Andrews Ice Manufacturing Co., Lebanon, Ohio, has been organized to manufacture ice and do a cold-storage business. Capital, $22,500. Incorporators, Frank Andrews, Chas. E. Monroe, Frank Brandon, etc.

The Provident Investment Co., Los Angeles, Calif., is planning the erection of an electric-lighting plant and installation of telephone system, at Modoc, Calif. C. B. Zimmerman, Modoc, resident manager, is in charge.

Power and refrigerating plants will be required for the Court Hall, a new apartment hotel to be built in Worcester, Mass., by Thomas D. Galasini and associates. Mr. Galasini's office is in the State Mutual Building.

The Yolo Water & Power Co., Oakland, Calif., has been incorporated with $10,000,000 capital by H. L. Breed, Leon M. Gove, M. S. Hamilton, etc. Power plant will be erected in the Coast Range Mountains, in Yolo County.

ENGINEERS WANTED

Under this head are published, without charge, advertisements of actual vacancies in power plants for operating engineers and assistant engineers. For the guidance of applicants for advertised positions, the advertisements must contain particulars to show the class of service demanded and the wages paid. Employers who desire to advertise under this head are requested to write for a blank form of application.

WANTED—Chief engineer for a plant in Manhattan vicinity; must be a man of executive ability, capable of taking charge of producers and gas engines, steam engines and boilers, and pumps; also to have charge of all machinery repairs in a large manufacturing plant; in replying, give experience, age, references and salary expected. Address Box 559, care Power.

HELP WANTED

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

WANTED—Engineers in every city to sell "Mackie" heaters. Mackie Heater Co., John Hancock Bldg., Boston, Mass.

AGENTS WANTED—To sell popular steam specialty; commission basis only. Address "Rekcutaw, Post Office Box 363, New York.

SALESMAN — Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," Power.

AGENTS for first-class steam specialty in use throughout United States. Address C. S. Wood, 410 S. 15th St., Philadelphia, Penn.

THE VULCAN SOOT CLEANER offers an exceptional opportunity for power specialty salesman Address G. L. Simonds & Co., 802 Steinway Bldg., Chicago, Ill.

MASTER MECHANIC wanted for pulp mill; used to construction and machinery installation; state age, experience and wages expected; application treated strictly confidential. Box 552, Power.

ESTIMATOR; assistant; young man familiar with steam heating, plumbing and refrigeration plans and layouts, figure from blueprints; salary $1000-$1500, depending on experience; all replies treated confidential. Employers Service Agency, 170 Broadway, New York.

WANTED—An experienced mine electrician who can wind armatures and keep in thorough repair, a half dozen direct current generators, a dozen locomotives, and several motors located at different mines; location a plain mining camp, on short branch in central West Virginia. Wanted, by same company, a superintendent-foreman for small mine having an output of 400 tons per day, man who can survey preferred; state age, experience fully, where obtained, in what positions, education and where obtained, married or single, teetotaler or otherwise, and salary expected. Address Box 563, Power.

SITUATIONS WANTED

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

MECHANICAL DRAFTSMAN, technical graduate, large experience in designing and constructing power plants and mills, desires position with chance for advancement. Box 565, Power.

POSITION WANTED by a single man, 28 years old, with mining company who require service of an engineer to take charge boilers, Corliss and high speed engines, dynamos and motors and air compressors. Address Box 554, Power.

POSITION as engineer or electrician; three years' experience in power plant work; thoroughly familiar with a.c. and d.c. machines; at present employed by large electrical manufacturing company; Ohio license. Address Box 561, Power.

POSITION WANTED—Mechanical engineer and designer, four years shop, 10 years office experience in the line of general machinery, engines, pumps, air compressors, power plants, reinforced concrete; best references. Box 562, Power.

MISCELLANEOUS

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

PATENTS SECURED—C. L. Parker, Patents, 904 G St., Washington, D. C.

VOLTAGE REGULATOR wanted for 100 kw., 220 v. alternator with direct connected exciter. Tremont Worsted Co., Methuen, Mass.

WANTED—A petroleum engine with tank complete, of twenty-five or thirty horsepower; must be in good condition. Room 1106, 347 Fifth Ave., New York.

EVERY ENGINEER should be posted regarding the new system of vacuum heating installed without payment of royalty; I have valuable information; write today. C. P. Monash, 1417 W. Jackson Blvd., Chicago, Ill.

ANNUAL MEETING of the stockholders of the Hill Publishing Company, for the election of directors for the ensuing year and for the transaction of such other business as may properly come before the meeting, will be held at the offices of the company, in the Hallenbeck Building, 497-505 Pearl St., Borough of Manhattan, New York City, N. Y., on Tuesday, January 30, 1912, at 12 o'clock noon.

Dated, New York City, Dec. 19, 1911.
Robert McKean, Secretary.

FOR SALE

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

FOR SALE—Five Corliss vertical water leg, and sixteen Manning vertical type boilers. J. & P. Coats, Ltd., Pawtucket, R. I.

FOR SALE—Three single-phase, 133-cycle, 1100-v. alternators, 250, 120 and 70 kw., with 15-panel marble switchboard; in operation until Jan. 15. Borough of Madison, Madison, N. J.

8x10 SKINNER ENGINE, direct connected to 30-kilowatt generator, and 8x10 Allfree engine, direct connected to 20-kilowatt generator . Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

ONE PAIR of Harris Corliss engines, girder frame, approximately 300 hp. diameter of cylinder, 16 in.; length of stroke, 48 in.; diameter of flywheel, 14 ft.; width of wheel, 2 ft. 6 in.; revolutions per minute, 54; engines can be seen at the factory of the Salt's Textile Mfg. Co., Bridgeport, Conn.

ONE GENERAL ELECTRIC direct current generator, type A, 4 pole, 45 kilowatt, No. 925, 360 amperes, 850 r.p.m., 110 volt, no load; 115 volt, full load; three horizontal return tubular boilers, makers, Bigelow Co., New Haven, Conn., 20 feet long, 72 inches in diameter, 94 tubes 3½ inches diameter; two horizontal return tubular boilers, makers, Bridgeport Boiler Works, Bridgeport, Conn., 20 feet long, 72 inches diameter, 94 tubes, 3½ inches diameter; one horizontal return tubular boiler, maker, Pacific Iron Works, Bridgeport, Conn., 17 feet long, 66 inches diameter, 68 tubes, 4-inch diameter. All in good condition, 100-lb. pressure allowed on the boilers by the Boiler Insurance Co., at time of removal. Box 564, Power.

Alphabetical Index to Advertisers

	Page
Albany Lubricating Co.	63
American District Steam Co.	91
American Engine Co.	110
American Engineering Co.	49
American Injector Co.	72
American Mfg. Co.	84
American Metal Hose Co.	82
American Pulley Co.	66
American Steam Gauge & Valve Mfg. Co.	40, 41
Ames Iron Works	110
Anderson Co., V. D.	78
Armstrong Mfg. Co.	66
Ashton Valve Co.	54
Austin Separator Co.	78
Babcock & Wilcox Co., The.	95
Ball Engine Co.	112
Baragwanath & Son, Wm.	70
Barnes Co., W. F. & John.	98
Bates Machine Co.	108
Betson Plastic Fire Brick Co.	99
Bignall & Keeler Mfg. Co.	59
Blake & Knowles Steam Pump Works	70
Bogart Gas Power Engineerin Co.	106
Bowser & Co., Inc., S. F.	65
Bristol Co.	4th cover
Bruce-Macbeth Engine Co.	106
Buckeye Boiler Skimmer Co.	99
Buckeye Engine Co.	112
Buffalo Steam Pump Co.	92
Borden Co.	66
Builders Iron Foundry	80
Burt Mfg. Co., The	14
Cameron Steam Pump Works, A. S.	91
Casey-Hedges Co.	97
Chapman Valve Mfg. Co.	57
Chesterton Co., A. W.	76
Cling-Surface Co.	83
Columbian Rope Co.	83
Columbus Machine Co.	107
Connersville Blower Co., The	92
Consolidation Coal Co.	13
Cooper Co., C. & G.	107
Crocker-Wheeler Co.,	1st cover
Crosby Steam Gage & Valve Co.	59
Curtis & Curtis Co., The	59
Cyclone Grate-Bar Co.	89
Dallett Co., Thos. H.	99
Dart Mfg. Co., E. M.	59
Daum Co., A. F.	98
Dearborn Drug & Chemical Works	5
De Laval Steam Turbine Co.	93
Deming Co.	92
Detroit Lubricator Co.	64
Diamond Rubber Co.	76
Direct Separator Co.	94
Dixon Crucible Co., Jos.	66
Elliott Co., 7, 57, 58, 65, 66, 69, 70,	79
Engineers Appliance Co., The	54
Epping-Carpenter Co.	92
Eureka Packing Co.	52, 53
Fitchburg Steam Engine Co.	112
Flexible Steel Lacing Co.	82
Flower Co., Walter L.	65
Foos Gas Engine Co.	106
Fort Wayne Electric Wks.	68
Franklin Oil Filter Co.	65
Garlock Packing Co.	9
General Electric Co.	113
Goetz Gasket & Packing Co.	76
Goodnow Fdry. Co., L. H.	83
Goulds Mfg. Co.	93
Graver Tank Works, Wm.	98
Green Engineering Co.	89
Green Fuel Economizer Co.	86
Greene, Tweed & Co., 51,	4th cover
Griffith & Wedge Co., The	108
Griscom-Spencer Co.	70
Hamler-Eddy Smoke Recorder Co.	98
Hammel Oil Burner Co.	76
Harbison-Walker Refractories Co.	101
Harris Steam Engine Co., W. A.	112
Harrisburg Foundry & Machine Works	110
Harrisburg Mfg. & Boiler Co.	94
Harrison Safety Boiler Works	43
Heine Safety Boiler Co.	96
Hess-Bright Mfg. Co., The.	85
Hewes & Phillips Iron Wks.	109
Hoffman, Geo. W.	95
Homestead Valve Mfg. Co.	58
Hooven, Owens, Rentschler Co.	109
Hoppes Mfg. Co.	72
Houston, Stanwood & Gamble Co.	109
Howard Iron Works	56
Huyette Co., Inc., Paul B.	72
Ingersoll-Rand Co.	105
International Corr. Schools.	47
Jeffrey Mfg. Co.	66
Jenkins Bros.	45
Johns-Manville Co., H. W.	77
Keeler Co., E.	97
Kennicott Co., The	96
Kerr Turbine Co.	107
Keystone Lubricating Co.	3
Lagonda Mfg. Co.	3d cover
Laidlaw-Dunn-Gordon Co., The	103
Leavitt Machine Co.	60
Liberty Mfg. Co.	7
Locke Regulator Co.	57, 108
Long Grate Bar Co., The.	87
Lunkenheimer Co.	4
Lytton Mfg. Corporation.	78
McClave-Brooks Co.	12
McCord Mfg. Co.	73
McGowan Co., The John H.	92
McGraw-Hill Book Co.	90
McIntosh, Seymour & Co.	100
McLeod & Henry Co.	100
Magnolia Metal Co.	103
Manzel Bros. Co.	64
Martin Grate Co.	89
Mason Regulator Co.	54
Mayville Specialty Mfg. Co.	99
Milne Water Tube Boiler Co.	95
Minneapolis Steel & Machinery Co.	107
Monarch Valve & Mfg. Co.	56
Morehead Mfg. Co.	79
Morrin Climax Boiler Co.	95
Morse Chain Co.	114
Murphy Iron Works	89
Nashua Machine Co.	78
National Pipe Bending Co.	69
National Tube Co.	67
Neemes Bros.	88
Nelson Valve Co.	55
New Bedford Valve Mfg. Co.	57
New Process Rawhide Co.	84
New York Belting & Packing Co., Ltd.	10
New York Edison Co.	86
Newhall Eng. Co., Geo. M.	81
Northern Equipment Co.	96
Nugent & Co., Wm. W.	65
Ohio Blower Co.	87
Ohio Brass Co.	58
Ohio Injector Co.	56
Oil City Boiler Works	94
Open Coil Heater & Purifier Co.	79
Oster Mfg. Co.	76
Otto Gas Engine Works	104
Page Belting Co.	83
Parker Boiler Co.	97
Parson Mfg. Co.	88
Patterson & Co., Frank L.	67
Peerless Rubber Mfg. Co.	8
Penberthy Injector Co.	11
Pennsylvania Flexible Metallic Tubing Co.	104
Perfection Grate Co.	89
Peroiln Co. of America	98
Pierce Co., Wm. B.	2d cover
Pittsburgh Valve, Foundry & Construction Co.	56
Powell Co., Wm.	57
Power & Mining Mchry. Co.	104
Power Specialty Co.	77
Precision Instrument Co.	96
Prince-Groff Co.	74, 75
Providence Engr. Works.	110
Quimby, Inc., Wm. E.	91
Reliance Gauge Column Co.	79
Remington Oil Engine Co.	108
Richardson-Phenix Co.	62
Ridgway Dynamo & Engine Co.	109
Robb Engineering Co., Ltd.	87
Robertson & Son, Jas. L.	53
Rogers Co., H. A.	76
Rollins Engine Co.	111
Rooksby & Co., E. J.	109

You Should Have The Full Details Of This American H_2O Grease Extracting Feed Water Filter

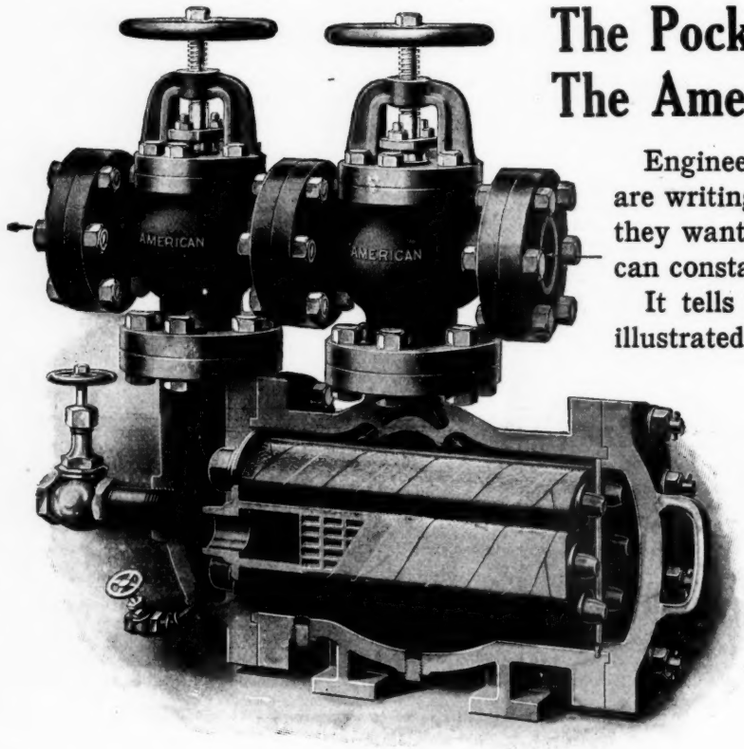
You as a practical power plant man are anxious to reduce overhead expenses as much as possible. You are therefore necessarily interested in any device that will help you get better results from your equipment, that will reduce maintenance expenses, and reduce time wastes and troublesome delays to a minimum.

You should get all the facts about this practical American H_2O Grease Extracting Feed Water Filter because this device, if you use condensation for boiler feed, will enable you to keep all oil out of the boilers.

Picture the trouble saving, time saving, expense saving.

No bagging plates to worry you—better results from your boiler—less danger of explosion and loss of life—fewer repairs—reduced boiler deterioration.

Let us send you the facts—just drop us a line and ask for



The Pocket Edition Of The American Catalog

Engineers all over the country are writing us for our catalog—they want it on file where they can constantly refer to it.

It tells about the device here illustrated—and it tells the story of the whole line of American Quality Power Plant Products.

It will pay you to have this book but it will cost you nothing to get it. Just write for it—but write now.

SIGN AND MAIL COUPON

American Steam Gauge & Valve Mfg. Co.
Boston, Mass 1-16-12

Send me your complete catalog

Name. . . . . .

Address . . . . . .

American Steam Gauge &

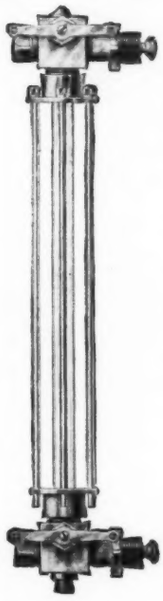
Boston,

Sales Offices in New York, Chicago, San

THE BEST HOUSES EVERY

Jenkins Bros. Boiler Specialties

A Safe Water Gauge

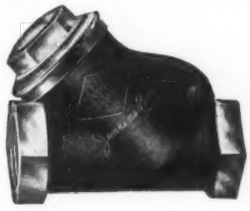


The Graber Indicating, Automatic Water Gauge has an automatic valve which closes instantly in case a gauge glass breaks, shutting off flow of steam or water and removing any danger of scalding.

The indicating lever on outside of gauge shows position of the automatic valve and as the valve cannot move without changing position of the lever there can be no danger of false water level.

It is made in two patterns, one for pressures up to 125 lbs.—the other for pressures up to 250 lbs.

Swing Check Valves



Jenkins Bros. Swing Check Valves are splendidly adapted for boiler feed service and similar work. Their construction is such they offer practically no obstruction to the flow of steam or fluid.

They are made from standard and extra heavy patterns, both brass and iron, in various styles, horizontal, angle, vertical and swing.

The Jenkins Disc with which each valve is fitted takes all the wear; the seat is seldom injured and the disc is easily renewed at little cost.

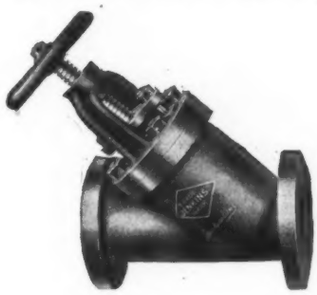
A Simple Durable Gauge Cock

This Ball Gauge Cock with Jenkins Composition Plug is to be relied upon for perfect service.

The Jenkins Packing used to make the seat lasts for years and when necessary can be renewed at slight cost.

The seat is always tight; when the packing is worn by use, all that is necessary to renew the joint is to true up the end of the packing piece with a file or sand paper and to turn the screw up until the ball stands horizontal.

"Y" or Blow Off Valves



Jenkins Bros. "Y" or Blow-Off Valves are strong and well-made, particularly serviceable for use as blow-off valves for boilers. They have a full opening nearly in line with the pipe. Consequently they permit a free flow of steam or fluids. They have renewable seat rings and discs. They are made screwed or flanged in Standard and Extra Heavy Patterns in brass or iron.

The cut shows one of the new style iron body valves with yoke.

Ask your dealer for Jenkins Bros. products. Their installation means added efficiency to any steam plant.

Jenkins Bros.

80 White St., New York **35 High St., Boston** **133 N. 7th St., Philadelphia** **300 West Lake St., Chicago**

Injectors
American Injector Co..... 72
Detroit Lubricator Co..... 64
Jenkins Bros..... 45
Lunkenheimer Co..... 4
Ohio Injector Co..... 56
Penberthy Injector Co.... 11
Robertson & Sons, Jas. L.. 53
Schutte & Koerting Co....102
Sherwood Mfg. Co..... 66

Lamps, Arc
General Electric Co.....113
Westinghouse Electric & Mfg. Co.....114

Lamps, Incandescent
General Electric Co.....113
Johns-Manville Co., H. W.. 77
Westinghouse Electric & Mfg. Co.....114

Lathes, Foot Power
Barnes Co., W. F. & John.. 98

Lubricators, Cylinder
Albany Lubricating Co.... 63
Detroit Lubricator Co..... 64
Flower Co., Walter L..... 65
Greene, Tweed & Co., 51, 4th cover
Griscom-Spencer Co..... 70
Keystone Lubricating Co.. 3
Lunkenheimer Co..... 4
Manzel Bros. Co..... 64
Ohio Injector Co..... 56
Penberthy Injector Co.... 11
Richardson-Phenix Co..... 62
Robertson & Son, Jas. L.. 53
Sherwood Mfg. Co..... 66

Lubricators, Force Feed
Greene, Tweed & Co., 51, 4th cover
Lunkenheimer Co..... 4
McCord Mfg. Co..... 73
Ohio Injector Co..... 56
Richardson-Phenix Co..... 62
Sherwood Mfg. Co..... 66

Mats and Matting
Diamond Rubber Co..... 76
New York Belting & Packing Co., Ltd..... 10
Peerless Rubber Mfg. Co.. 8

Metal, Bearing
Magnolia Metal Co.....103

Meters, Steam
St. John, G. C..... 94

Meters, Water
Builders Iron Foundry.... 80
Elliott Co., 7, 57, 58, 65, 66, 69, 70, 79
St. John, G. C..... 94
Harrison Safety Boiler Works 43

Micrometers
Starrett Co., L. S..... 92

Milling Machines, Portable
Underwood & Co., H. B....102

Motors, Electric
American Engine Co.....110
Crocker-Wheeler Co., 1st cover
Fort Wayne Electric Wks. 68
General Electric Co.....113
Ridgway Dynamo & Engine Co.....109
Sturtevant Co., B. F.....108
Westinghouse Electric & Mfg. Co.....114

Motors, Water
Elliott Co., 7, 57, 58, 65, 66, 69, 70, 79
Liberty Mfg. Co..... 7
Lagonda Mfg. Co....3d cover

Oil and Grease Cups
Albany Lubricating Co... 63
American Injector Co..... 72
Detroit Lubricator Co..... 64
Elliott Co., 7, 57, 58, 65, 66, 69, 70, 79
Griscom-Spencer Co..... 70
Keystone Lubricating Co.. 3
Lunkenheimer Co..... 4
Ohio Injector Co..... 56
Penberthy Injector Co.... 11
Schaeffer & Budenberg Mfg. Co..... 67
Sherwood Mfg. Co..... 66

Oil Burners
Hammel Oil Burner Co.... 76
Lunkenheimer Co..... 4
Parson Mfg. Co..... 88

Oil Reservoirs
Bowser & Co., Inc., S. F... 65
Burt Mfg. Co..... 14
Graver Tank Works, Wm. 98
Richardson-Phenix Co..... 62

Oil Tanks
Bowser & Co., Inc., S. F... 65
Richardson-Phenix Co..... 62

Oilers, Telescopic
Nugent & Co., Wm. W.... 65
Penberthy Injector Co.... 11

Oiling Devices
Albany Lubricating Co.... 63
Lunkenheimer Co..... 4
Nugent & Co., Wm. W.... 65
Penberthy Injector Co..... 11
Sherwood Mfg. Co..... 66

Oiling Systems
Albany Lubricating Co.... 63
Bowser & Co., Inc., S. F... 65
Burt Mfg. Co..... 14
Detroit Lubricator Co..... 64
Elliott Co., 7, 57, 58, 65, 66, 69, 70, 79
Lunkenheimer Co..... 4
Nugent & Co., Wm. W.... 65
Richardson-Phenix Co..... 62

Oils
Albany Lubricating Co.... 63
Dearborn Drug & Chemical Works 5
Standard Oil Co..... 63

Packing, Cylinder
Rooksby & Co., E. J.....109

Packing, Flange
Chesterton Co., A. W..... 76
Diamond Rubber Co..... 76
Eureka Packing Co.....52, 53
Garlock Packing Co..... 9
Goetze Gasket & Packing Co. 76
Greene, Tweed & Co., 51, 4th cover
Jenkins Bros..... 45
Johns-Manville Co., H. W. 77
Keeler Co., E..... 97
McCord Mfg. Co..... 73
New York Belting & Packing Co., Ltd.....
Peerless Rubber Mfg. Co.. 10
Smooth-On Mfg. Co..... 6

Packing, Hydraulic
Chesterton Co., A. W..... 76
Diamond Rubber Co..... 76
Eureka Packing Co.....52, 53
Garlock Packing Co..... 9
Goetze Gasket & Packing Co. 76
Johns-Manville Co., H. W. 77
Schieren Co., Chas. A..... 82
Steel Mill Packing Co.... 77
Walker & Co., Ltd., James. 77

Packing, Metallic
Goetze Gasket & Packing Co. 76

Packing, Pump Valve
Diamond Rubber Co..... 76

Packing, Rod
Chesterton Co., A. W..... 76
Diamond Rubber Co..... 76
Eureka Packing Co.....52, 53
Flower Co., W. L..... 65
Garlock Packing Co..... 9
Goetze Gasket & Packing Co. 76
Greene, Tweed & Co., 51, 4th cover
Johns-Manville Co., H. W. 77
New York Belting & Packing Co., Ltd..... 10
Peerless Rubber Mfg. Co.. 8
Power Specialty Co..... 77
Steel Mill Packing Co..... 77
Tripp Metallic Packing Co. 77
Walker & Co., Ltd., James. 77

Packing, Valve Stem
Diamond Rubber Co..... 76
Eureka Packing Co.....52, 53
Garlock Packing Co..... 9
Greene, Tweed & Co., 51, 4th cover
Tripp Metallic Packing Co. 77

Paint, Graphite
United States Graphite Co. 61

Pipe
Harrisburg Mfg. & Boiler 94
National Tube Co..... 67

Pipe Bending
National Pipe Bending Co. 69
Whitlock Coil Pipe Co.... 69

Pipe Clamp
Yarnall-Waring Co..... 57

Pipe Coils
National Pipe Bending Co. 69
National Tube Co..... 67
Whitlock Coil Pipe Co.... 69

Pipe Cutting and Threading Machines
Armstrong Mfg. Co..... 66
Bignall & Keeler Mfg. Co. 59
Borden Co..... 66
Curtis & Curtis Co..... 59
Oster Mfg. Co..... 76
Toledo Pipe Threading Machine Co..... 59
Treadwell Co., Inc., M. H.. 89
Trimont Mfg. Co..... 94
Williams & Co., J. H..... 91

Pipe Fittings
Lunkenheimer Co..... 4
National Tube Co..... 67
Pittsburg Valve Foundry & Construction Co..... 56
Trimont Mfg. Co..... 94

Pipe, Joint Compound
Dixon Crucible Co., Jos... 66

Pipe, Riveted Steel
Graver Tank Works, Wm. 98
Harrisburg Mfg. & Boiler Co. 94

Pipe, Welded & Seamless
National Tube Co..... 67

Piping, Blower
Ohio Blower Co..... 87

Piping, High Pressure
Whitlock Coil Pipe Co.... 69

Planimeters
American Steam Gauge & Valve Mfg. Co.....40, 41
Robertson & Sons, Jas. L.. 53
Schaeffer & Budenberg Mfg. Co..... 67
Trill Indicator Co..... 67

Plumbago
Dixon Crucible Co., Jos... 66
United States Graphite Co. 61

Polish, Metal
Chesterton Co., A. W..... 76
Hoffman, Geo. W..... 95
Johns-Manville Co., H. W. 77

Publishers
International Corr. Schools. 47
McGraw-Hill Book Co..... 90

Pulleys
American Pulley Co..... 66
Goodnow Fdry. Co., L. H.. 83
Greene, Tweed & Co., 51, 4th cover
Minneapolis Steel & Machinery Co.....107
Saginaw Mfg. Co..... 83

Pumps, Air
Cameron Steam Pump Works, A. S..... 91
Deming Co..... 92
McGowan Co., John H..... 92
Wheeler Cond. & Engr. Co. 92
Wheeler Mfg. Co., C. H... 93

Pumps, Centrifugal
De Laval Steam Turbine Co. 93
Deming Co..... 92
Quimby, Inc., Wm. E..... 91
Terry Steam Turbine Co.. 67
Worthington, Henry R.... 78

Pumps, Deep Well
Cameron Steam Pump Works, A. S..... 91
Deming Co..... 92
McGowan Co., John H..... 92

Pumps, Electric
Cameron Steam Pump Works, A. S..... 91
De Laval Steam Turbine Co. 93
Deming Co..... 92
Goulds Mfg. Co..... 93
Quimby, Inc., Wm. E..... 91

Pumps, Force Feed
Richardson-Phenix Co..... 62

Pumps, Jet
McGowan Co., John H..... 92

Pumps, Oil
Burt Mfg. Co..... 14
Cameron Steam Pump Works, A. S..... 91
Deming Co..... 92
Goulds Mfg. Co..... 93
Lunkenheimer Co..... 4
Manzel Bros. Co..... 64
Patterson & Co., Frank L.. 67
Quimby, Inc., Wm. E..... 91
Richardson-Phenix Co..... 62
Sherwood Mfg. Co..... 66

Pumps, Oil Force-feed
Detroit Lubricator Co..... 64
Lunkenheimer Co..... 4
Richardson-Phenix Co..... 62

Pumps, Pneumatic
Ingersoll-Rand Co.....105

Pumps, Power
Cameron Steam Pump Works, A. S..... 91
Deming Co..... 92
Patterson & Co., Frank L.. 67
Quimby, Inc., Wm. E..... 91
Wheeler Mfg. Co., C. H... 93
Whitlock Coil Pipe Co.... 69

Pumps, Screw
Quimby, Inc., Wm. E..... 91

Pumps, Steam
Cameron Steam Pump Works, A. S..... 91
De Laval Steam Turbine Co. 93
Deming Co..... 92
Epping-Carpenter Co..... 92
Ingersoll-Rand Co.....105
McGowan Co., John H..... 92
Mason Regulator Co..... 54
Minneapolis Steel & Machinery Co.....107
Wheeler Condenser & Engineering Co..... 92
Wheeler Mfg. Co., C. H... 93
Worthington, Henry R.... 78

Pumps, Turbine
De Laval Steam Turbine Co. 93

Pumps, Vacuum
Cameron Steam Pump Works, A. S..... 91
Connersville Blower Co., The 92
McGowan Co., John H..... 92
Wheeler Cond. & Engr. Co. 92
Wheeler Mfg. Co., C. H.... 93

Pyrometers
American Steam Gauge & Valve Mfg. Co.....40, 41
Schaeffer & Budenberg Mfg. Co..... 67

Rams, Steam
Penberthy Injector Co.... 11

Reducing Wheels
American Steam Gauge & Valve Mfg. Co.....40, 41
Robertson & Sons, Jas. L.. 53
Trill Indicator Co..... 67

Regulators, Damper
Elliott Co., 7, 57, 58, 65, 66, 69, 70, 79
Lagonda Mfg. Co....3d cover
Locke Regulator Co....57, 108
Mason Regulator Co..... 54
Robertson & Sons, Jas. L.. 53
Schaeffer & Budenberg Mfg. Co..... 67
"S-C" Regulator Co..... 99
Turbo-Blower Co..... 72

Regulators, Feed Water
American District Steam Co..... 91
Elliott Co., 7, 57, 58, 65, 66, 69, 70, 79
Harrison Safety Boiler Works 43
Lagonda Mfg. Co....3d cover
Mason Regulator Co..... 54
Northern Euipment Co.... 96
"S-C" Regulator Co..... 99
Squires Co., C. E..... 80

Regulators, Pressure
American District Steam Co..... 91
Elliott Co., 7, 57, 58, 65, 66, 69, 70, 79
Lagonda Mfg. Co....3d cover
Lytton Mfg. Corporation.. 78
Mason Regulator Co..... 54
Northern Equipment Co... 96
Ohio Brass Co..... 58
Robertson & Sons, Jas. L.. 53
Squires Co., C. E..... 80
Watson & McDaniel Co.... 93

Regulators, Pump
Elliott Co., 7, 57, 58, 65, 66, 69, 70, 79
Mason Regulator Co..... 54
Squires Co., C. E..... 80
"S-C" Regulator Co..... 99

Revolution Counters
American Steam Gauge & Valve Mfg. Co.....40, 41
Ashton Valve Co., The.... 54
Schuchardt & Schütte..... 80
Starrett Co., L. S..... 92

Rheostats
General Electric Co.....113

Rope, Transmission
American Mfg. Co..... 84
Columbian Rope Co..... 83

Do You Want This Job?

It Pays $65 a Week

There are thousands of just such jobs awaiting the trained man. In every section, in every state, and in every city there are factories to be superintended; machinery to be repaired; railroads to be built and maintained; residences and business blocks to be erected; canals, cuts, and tunnels to be dug; or power plants to be constructed and engineered.

Who should be in charge of this work? YOU.

Who should receive the high salaries paid for such work? YOU.

Who should qualify to successfully handle this work? YOU.

The progress of this age is not going to stop, and some one must do this work. Will it be you or the other fellow? One thing is certain: it will be the man best qualified for the job.

Thousands of I. C. S. students are today heads of the largest manufacturing, inventive, constructive, and business enterprises, and chief engineers of power plants. And for 20 years it has been the business of the I. C. S. to prepare men for such positions. But today there are more businesses than ever, more opportunities than ever, and there must be more trained men than ever to fill the many positions.

Let us help you to qualify for a bigger job. What we have done for tens of thousands of others we can do for you.

You need only mark and mail the attached coupon and you will receive, without obligation or cost, full information about any position in which you may be interested.

Mark and Mail the Coupon TODAY

International Correspondence Schools
Box 979, SCRANTON, PA.

Please explain, without further obligation on my part, how I can qualify for a larger salary in the position, trade, or profession before which I have marked X.

Electrical Engineer	Machinist	Chemist
Electrical Mach. Des.	Toolmaking	Assayer
Dynamo Foreman	Molding	Commer'l Illustrat'g
Electric Lighting	Blacksmithing	Bookkeeper
Electric Railways	Civil Engineer	Stenographer
Electrician	Stationary Engineer	Civil Service Exams.
Telephone Expert	Gas Engineer	Commercial Law
Concrete Construct'n	Refrigeration Eng.	Architecture
Mechanical Engineer	Sheet-Metal Drafts.	Contracting & Build'g
Machine Designer	Marine Engineer	Advertising Man
Mechanical Draft.	Mining Engineer	Window Trimming
Patternmaking	Structural Engineer	Automobile Running

*Name*_____

*Street & No.*_____

*City*_____ *State*_____

*Present Occupation*_____

Rubber Joints
Diamond Rubber Co..... 76

Second Hand Machinery
Hewes & Phillips Iron Works 109

Separators, Ammonia
Direct Separator Co..... 94
Elliott Co., 7, 57, 58, 65, 66, 69, 70, 79
Harrison Safety Boiler Works 43

Separators, Oil
Austin Separator Co..... 78
Baragwanath & Son, Wm. 70
Direct Separator Co..... 94
Elliott Co., 7, 57, 58, 65, 66, 69, 70, 79
Harrison Safety Boiler Works 43
Hoppes Mfg. Co..... 72
Liberty Mfg. Co..... 7
Nashua Machine Co..... 78
Ohio Blower Co..... 87
Robertson & Son, Jas. L.. 53
Wright Mfg. Co..... 78

Separators, Steam
Austin Separator Co..... 78
Baragwanath & Son, Wm. 70
Direct Separator Co..... 94
Elliott Co., 7, 57, 58, 65, 66, 69, 70, 79
Griscom-Spencer Co..... 70
Harrison Safety Boiler Works 43
Hoppes Mfg. Co..... 72
Keeler Co., E..... 97
Liberty Mfg. Co..... 7
Nashua Machine Co..... 78
Ohio Blower Co..... 87
Patterson & Sons, Jas. L.. 67
Robertson & Sons, Jas. L.. 53
Watson & McDaniel Co... 93
Whitlock Coil Pipe Co.... 69
Wright Mfg. Co..... 78

Shaft Hangers
Roversford Foundry & Machine Co..... 84

Sight Feeds
Richardson-Phenix Co..... 62

Skylights
Burt Mfg. Co..... 14

Smoke Recorders
Hamler-Eddy Smoke Recorder Co..... 98

Spray Nozzles
Buffalo Steam Pump Co... 92
Schutte & Koerting Co...102

Stokers, Chain Grate
Babcock & Wilcox Co..... 95
Green Sngineering Co..... 89

Stokers, Mechanical
American Engineering Co. 49
Babcock & Wilcox Co..... 95
McClave-Brooks Co..... 12
Murphy Iron Works 89
Parson Mfg. Co..... 88
Under-Feed Stoker Co. of America 82

Strainers, Pump Suction
American Engineering Co. 49
Elliott Co., 7, 57, 58, 65, 66, 69, 70, 79
Lagonda Mfg. Co....3d cover

Strainers, Water
American Injector Co..... 72
Elliott Co., 7, 57, 58, 65, 66, 69, 70, 79
Lagonda Mfg. Co....3d cover
Liberty Mfg. Co..... 7

Superheaters
Babcock & Wilcox Co..... 95
Lagonda Mfg. Co....3d cover
Parker Boiler Co..... 97
Power Specialty Co..... 77
Providence Engr. Works..110
Whitlock Coil Pipe Co..... 69

Switchboards
General Electric Co.....113
Westinghouse Electric & Mfg. Co.....114

Switches, Electric
General Electric Co.....113

Tachometers
Schuchardt & Schütte..... 80
Schaeffer & Budenberg Mfg. Co..... 67

Tanks
Graves Tank Works, Wm.. 98
Griscom-Spencer Co..... 70
Keeler Co., E..... 97
Morrin-Climax Boiler Co.. 95
Scaife & Sons Co., Wm. B.. 99
Wright Mfg. Co..... 78

Taps, Stocks and Dies
Armstrong Mfg. Co..... 66
Bignall & Keeler Mfg. Co. 59
Curtis & Curtis Co..... 59
Oster Mfg. Co..... 76
Toledo Pipe Threading Machine Co..... 59

Thermometers
American Steam Gauge & Valve Mfg. Co.....40, 41
Bristol Co..... 4th cover
Schaeffer & Budenberg Mfg. Co..... 67

Tools, Portable Repair
Rooksby & Co., E. J.....109
Underwood & Co., H. B...102

Transformers
American Steam Gauge & Valve Mfg. Co.....40, 41
General Electric Co.....113
Westinghouse Electric & Mfg. Co.....114

Transmission, Power
American Mfg. Co..... 84
Columbian Rope Co..... 83
Roversford Foundry & Machine Co..... 84
Saginaw Mfg. Co..... 83

Traps, Return
Lytton Mfg. Corporation.. 78
Nashua Machine Co..... 78

Traps, Steam
American District Steam Co. 91
Anderson Co., V. D..... 78
Direct Separator Co..... 94
Elliott Co., 7, 57, 58, 65, 66, 69, 70, 79
Griscom-Spencer Co..... 70
Jenkins Bros..... 45
Harrison Safety Boiler Works 43
Lytton Mfg Corporation.. 78
Morehead Mfg. Co..... 79
Nashua Machine Co..... 78
Newhall Eng. Co., Geo. M. 81
Ohio Blower Co..... 87
Open Coil Heater & Purifier Co..... 79
Reliance Gauge Column Co. 79
Rogers Co., H. A..... 76
Schutte & Koerting Co....102
Squires Co., C. E..... 80
Watson & McDaniel Co.... 93
Wright Mfg. Co..... 78

Traps, Vacuum
Griscom-Spencer Co..... 70
Lytton Mfg. Corporation.. 78
Morehead Mfg. Co..... 79
Nashua Machine Co..... 78
Open Coil Heater & Purifier Co..... 79
Schutte & Koerting Co....102

Tube Cap Reseating Machines
Lagonda Mfg. Co.....3d cover

Tube Cutters
Armstrong Mfg. Co..... 66
Lagonda Mfg. Co.....3d cover
Liberty Mfg. Co..... 7

Tube Expanders
Liberty Mfg. Co..... 7

Tube Protectors
Liberty Mfg. Co..... 7

Tubing
Johns-Manville Co., H. W. 77
National Tube Co..... 67

Tubing, Metallic
Pennsylvania Flexible Metallic Tubing Co.....104

Turbines, Centrifugal
Terry Steam Turbine Co.. 67

Turbines, Generating
General Electric Co.... ..113

Turbines, Steam
De Laval Steam Turbine Co. 93
General Electric Co.....113
Hooven, Owens, Rentschler Co. 109
Kerr Turbine Co.....107
Sturtevant Co., B. F.....108
Terry Steam Turbine Co.. 67
Wing Mfg. Co., L. J..... 58

Unions
Dart Mfg. Co., E. M..... 59
Goetze Gasket & Packing Co. 76
Lunkenheimer Co..... 4
National Tube Co..... 76
Ohio Brass Co..... 58

Valve Balls
Diamond Rubber Co..... 76

Valve Disks
Diamond Rubber Co..... 76
Goetze Gasket & Packing Co. 76

Valve Reseating Machines
Leavitt Machine Co..... 60

Valve Washers, Leather
Schieren Co., Chas. A..... 82

Valves, Ammonia
Chapman Valve Mfg. Co.. 57
Monarch Valve & Mfg. Co. 56

Valves, Angle
Homestead Valve Mfg. Co. 58
Lunkenheimer Co..... 4
Monarch Valve & Mfg. Co. 56
National Tube Co..... 67
Nelson Valve Co..... 55
New Bedford Valve Mfg. Co. 57

Valves, Automatic Cutoff
Lagonda Mfg. Co....3d cover

Valves, Back Pressure
Harrison Safety Boiler Works 43
Jenkins Bros..... 45
Lytton Mfg. Corporation.. 78
McGowan Co., John H..... 92
Schutte & Koerting Co....102

Valves, Blowoff
Ashton Valve Co., The.... 54
Elliott Co., 7, 57, 58, 65, 66, 69, 70. 79
Homestead Valve Mfg. Co. 58
Howard Iron Works..... 56
Jenkins Bros..... 45
Lunkenheimer Co..... 4
Lytton Mfg. Corporation.. 78
Nelson Valve Co..... 55
Powell Co., Wm..... 57
Yarnall-Waring Co..... 57

Valves, Bypass
Mason Regulator Co..... 54
Monarch Valve & Mfg. Co. 56
Nelson Valve Co..... 55

Valves, Check
Greene, Tweed & Co., 51, 4th cover
Jenkins Bros..... 45
Lunkenheimer Co..... 4
Monarch Valve & Mfg. Co. 56
National Tube Co..... 67
Nelson Valve Co..... 55
Northern Equipment Co... 96

Valves, Cylinder Relief
American Steam Gauge & Valve Mfg. Co.....40, 41
Ashton Valve Co., The..... 54
Lunkenheimer Co..... 4
Nelson Valve Co..... 55

Valves, Exhaust Relief
Jenkins Bros..... 45
Nelson Valve Co..... 55

Valves, Float
Engineers Appliance Co., The 54
Homestead Valve Mfg. Co. 58
Schade Valve Mfg. Co..... 54

Valves, Free Exhaust
Schutte & Koerting Co....102

Valves, Gate
Chapman Valve Mfg. Co... 57
Detroit Lubricator Co..... 64
Greene, Tweed & Co., 51, 4th cover
Jenkins Bros..... 45
Lunkenheimer Co..... 4
Monarch Valve & Mfg. Co. 56
National Tube Co..... 67
Nelson Valve Co..... 55
New Bedford Valve Mfg. Co. 57
Ohio Brass Co..... 58
Pittsburgh Valve, Foundry & Construction Co..... 56
Powell Co., Wm..... 57

Valves, Globe
Detroit Lubricator Co..... 64
Jenkins Bros..... 45
Lunkenheimer Co..... 4
National Tube Co..... 67
Nelson Valve Co..... 55
New Bedford Valve Mfg. Co. 57
Ohio Brass Co..... 58
Powell Co., Wm..... 57

Valves, Pump
Garlock Packing Co..... 9
Jenkins Bros..... 45
New York Belting & Packing Co., Ltd..... 10
Peerless Rubber Mfg. Co.. 8
Schade Valve Mfg. Co..... 54

Valves, Reducing
Locke Regulator Co....57, 108
Lytton Mfg. Corporation.. 78
Mason Regulating Co..... 54
Ohio Brass Co..... 58
Schade Valve Mfg. Co..... 54
Schutte & Koerting Co....102
Squires Co., C. E..... 80

Valves, Regrinding
Lunkenheimer Co..... 4
National Tube Co..... 67
Nelson Valve Co..... 55

Valves, Regulating
Engineers Appliance Co., The 54
Lunkenheimer Co..... 4
Lytton Mfg. Corporation.. 78
Mason Regulator Co..... 54
Nelson Valve Co..... 55
Ohio Brass Co..... 58
Schade Valve Mfg. Co..... 54
Squires Co., C. E..... 80

Valves, Return Stop
Lagonda Mfg. Co....3d cover
Locke Regulator Co....57, 108

Valves, Safety
American Steam Gauge & Valve Mfg. Co.....40, 41
Ashton Valve Co., The.... 54
Crosby Steam Gage & Valve Co. 59
Detroit Lubricator Co..... 64
Jenkins Bros..... 45
Lagonda Mfg. Co....3d cover
Lunkenheimer Co..... 4
National Tube Co..... 67
Pittsburgh Valve, Foundry & Construction Co..... 56
Powell Co., Wm..... 57

Valves, Stop Check
Jenkins Bros..... 45
Lagonda Mfg. Co....3d cover
Schutte & Koerting Co....102

Valves, Superheated Steam
Chapman Valve Mfg. Co.. 57
Lunkenheimer Co..... 4
Nelson Valve Co..... 55
Schutte & Koerting Co....102

Valves, Tank
Engineers Appliance Co., The 54
Nelson Valve Co..... 55
Schade Valve Mfg. Co..... 54

Valves, Throttle
Detroit Lubricator Co..... 64

Valves, Trip Throttle
Schutte & Koerting Co....102

Ventilators
Burt Mfg. Co..... 14
Green Fuel Economizer Co. 86
Ohio Blower Co..... 87
Schutte & Koerting Co....102
Turbo-Blower Co..... 72
Wing Mfg. Co., L. J..... 58

Vises
Armstrong Mfg. Co..... 66
Curtis & Curtis Co..... 59
Williams & Co., J. H..... 91

Water Columns
American Steam Gauge & Valve Mfg. Co.....40, 41
Elliott Co., 7, 57, 58, 65, 66, 69, 70, 79
Huyette Co., Inc., P. B.... 72
Lunkenheimer Co..... 4
National Tube Co..... 67
Reliance Gauge Column Co. 79
Robertson & Son, Jas. L.. 53
Wright Mfg. Co..... 78

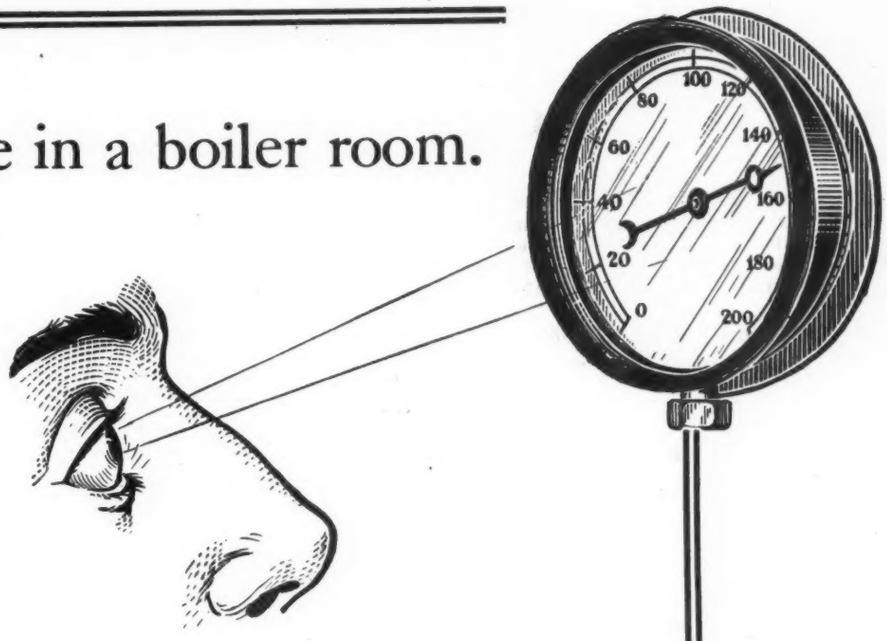
Water Softening Apparatus
Dearborn Drug & Chemical Works 5
Graver Tank Works, Wm. 98
Harrison Safety Boiler Works 43
Scaife & Sons Co., Wm. B. 99

Whistles
American Steam Gauge & Valve Mfg. Co.....40, 41
Ashton Valve Co., The.... 54
Crosby Steam Gauge & Valve Co..... 59
Lunkenheimer Co..... 4

Wrenches, Nut and Bolt
Trimont Mfg. Co..... 94
Williams & Co., J. H..... 91

Wrenches, Pipe
Armstrong Mfg. Co..... 66
Curtis & Curtis Co..... 59
Trimont Mfg. Co..... 94
Williams & Co., J. H..... 91

YOU are in a boiler room.



Your eye is on the steam gauge. It registers 150 lbs. Suddenly there is a twitch of the hand toward 145. Through the door from the engine room comes the quick whirr of the blower. Cranks ranged along the front of the boiler battery start a slow steady stroke, and, a moment or two after, the steam gauge hand creeps back to 150. Possibly it moves a little higher than 150. The whirr of the blower lessens, stroke of the cranks slows, the hand falls back to 150 lbs. It stays there. No one has done anything. Everything is mechanical.

When the steam pressure fell below 150, the difference was felt instantly by the blower engine—through a chronometer valve positive connected with the steam line—and the engine speeded up the fan and the cranks driving the rams that push the coal beneath the burning fire—speeded them up simultaneously.

Look around and see the name on the installation—

It's The Taylor Stoker

Steady steam pressure by mechanical regulation of the burning fire—that is the "Taylor System of Combustion." But the Taylor Stoker means more—than just that.

1.—It means perfect regulation of coal and air to each other to get all the burning qualities out of the coal—and the least possible loss of heat.

2.—Not TOO MUCH air—and a cooled furnace—heat driven up the stack—not TOO LITTLE air—and unconsumed coal.

3.—Air supply adjusted to the quantity and quality of coal, coal driven beneath the burning fuel.

4.—Both air and coal adjusted to the steam pressure you want.

The New Taylor Catalogue and the booklet "Results From Tests" will make interesting reading for you. Send for them.

THE TAYLOR STOKER BUILT EXCLUSIVELY BY THE

AMERICAN ENGINEERING COMPANY

SUCCESSORS TO THE TAYLOR STOKER COMPANY, AMERICAN SHIP WINDLASS COMPANY AND WILLIAMSON BROTHERS COMPANY

MACHINISTS AND FOUNDERS

PHILADELPHIA

Vol. 35. No. 3.

OUTLINE OF TOPICS

HIGH VACUUM, RECIPROCATING ENGINES:

High vacuum may be employed to advantage providing the exhaust ports and passages of low-pressure cylinder are properly designed. H. Fothergill.
POWER JAN. 16 Page 72

A BOILER ROOM ARGUMENT:

Denny, the fireman, expresses some decided opinions favoring the steam jet over the fan blower. F. Webster.
POWER JAN. 16 Page 74

SMOKE PREVENTION WITH STEAM JETS:

The introduction of steam jets over the fire results in a large reduction in smoke and an increased plant efficiency. J. A. Switzer.
POWER JAN. 16 Page 75

WHY "BLOCK" STATIONS DO NOT THRIVE:

The main reasons are because central station rates are lowered temporarily to stifle them and users of power do not appreciate their possibilities. H. D. Jackson.
POWER JAN. 16 Page 78

APPLICATION OF PROF. BONE'S BOILER:

The first boiler constructed for actual service has a diameter of 10 ft., is 4 ft. long and is capable of evaporating 5500 lb. of water per hour.
POWER JAN. 16 Page 80

ELECTRICAL REDUCTION FOR SHIP PROPULSION:

The advantage of installing an electric generator and motor rather than reduction gearing between the turbine and the propeller. W. L. R. Emmet.
POWER JAN. 16 Page 81

THE PASSING OF ONE OF CORLISS' FIRST ENGINES:

A double walking-beam engine designed over 60 years ago for the Pacific Mills, of Lawrence, Mass.
POWER JAN. 16 Page 82

LOCATING DEFECTS IN DIRECT CURRENT ARMATURES:

Location of short-circuits, open circuits, grounds and cross connections by the use of an inducing magnet. Gordon Fox.
POWER JAN. 16 Page 83

THE WESTINGHOUSE LOAD-EQUALIZING HOISTING SET:

In which a heavy flywheel smooths out the peak of the hoisting cycle and all excess energy in descending cage is returned to flywheel.
POWER JAN. 16 Page 84

AN EASY PROBLEM IN STAR CONNECTIONS:

W. Russell Cooper. Page 85

ROTARY CONVERTERS VS. MOTOR GENERATORS:

H. D. Jackson. Page 86

A SIMPLE WAY TO PUT AN INDEX ON A VOLTMETER:

S. H. Winterbottom. Page 86

MOTOR LINE CURRENT:

S. R. Wing. Page 86

COAL REQUIRED TO HEAT MODERN CITY BUILDING:

To compute the annual coal consumption a method is proposed in which the heat loss due to air leakage is combined with the loss due to transmission and both expressed in terms of equivalent glass surface. E. F. Tweedy.
POWER JAN. 16 Page 87

CONTINUOUS VS. INTERMITTENT HEATING:

H. H. Hastings. Page 90

EDITORIALS 91-92

One Man Shifts in Power Plant

Steam Boiler Operation

Steam Piping

READERS WITH SOMETHING TO SAY 93-95

Corrosion of Boiler Tubes in Nashville
Homemade Auxiliary Heater
Engine Needs Compression
On Keeping Record of Plant Performances
A Clutch That More Than Paid for Itself
Sight Seeing in a City Factory
Feed Pipe Arrangement

QUESTIONS BEFORE THE HOUSE 96-98

Engine Runs with Steam Valves Closed
Expert Advice
Vibrations of the Indicator Pencil
Wrought Iron Tap
Burning Fuel Oil
Central Station vs. Isolated Plant
Using the Firm's Stationery
Emergency Die Stock
Engineer's Reference Book

INQUIRIES OF GENERAL INTEREST 99
NEWS 100
MOMENTS WITH THE AD. EDITOR 37
ADVERTISING INDEX 39